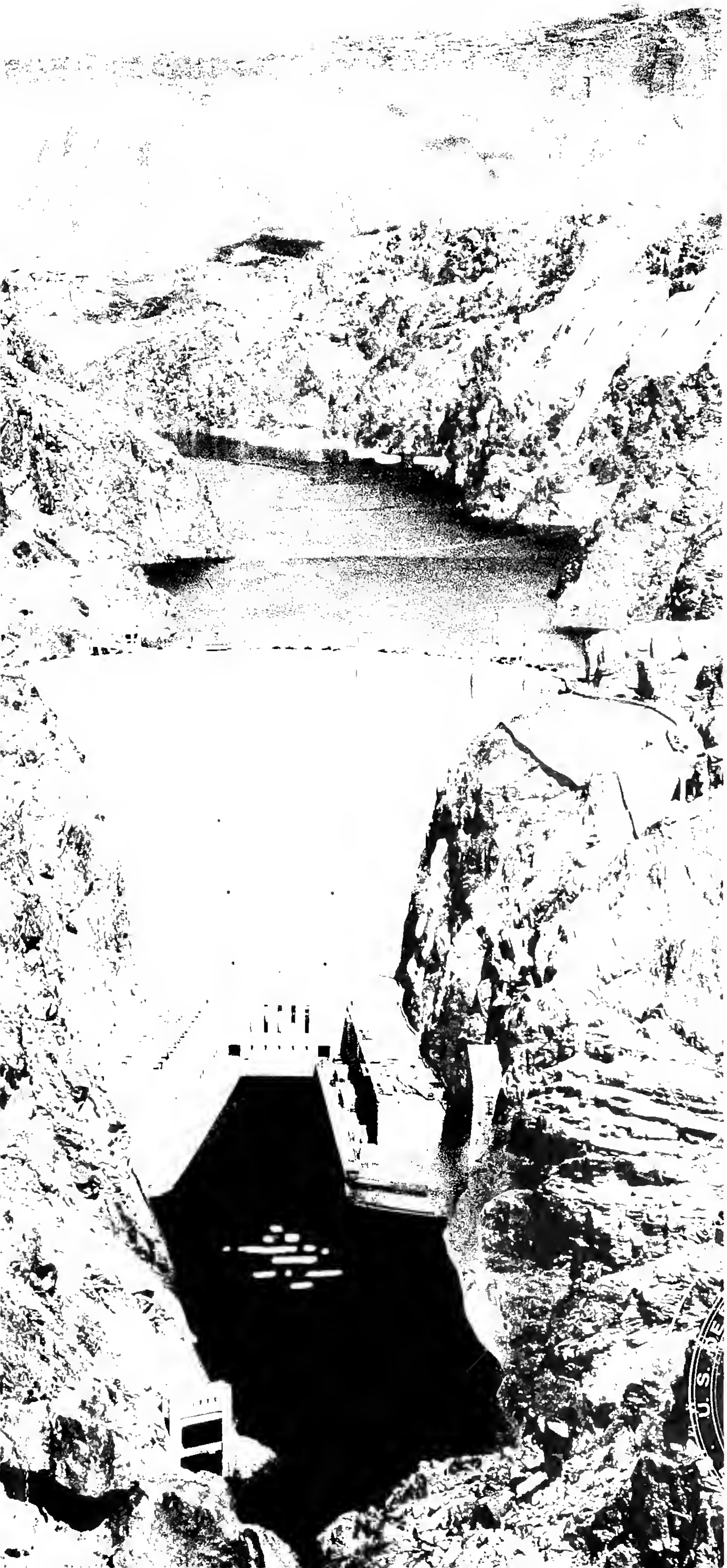


Hydropower 2002

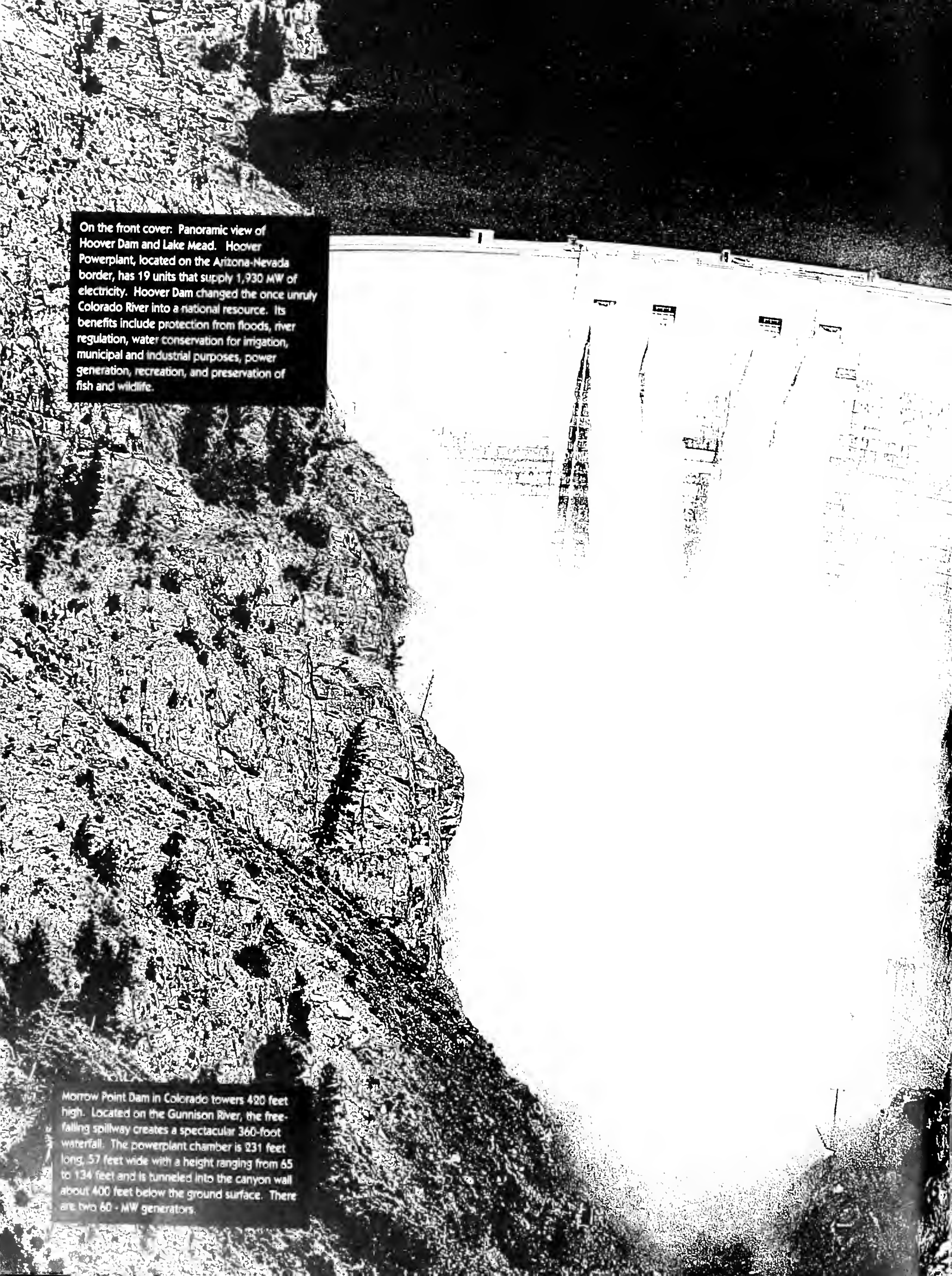
Reclamation's Energy Initiative

United States
Department of the Interior

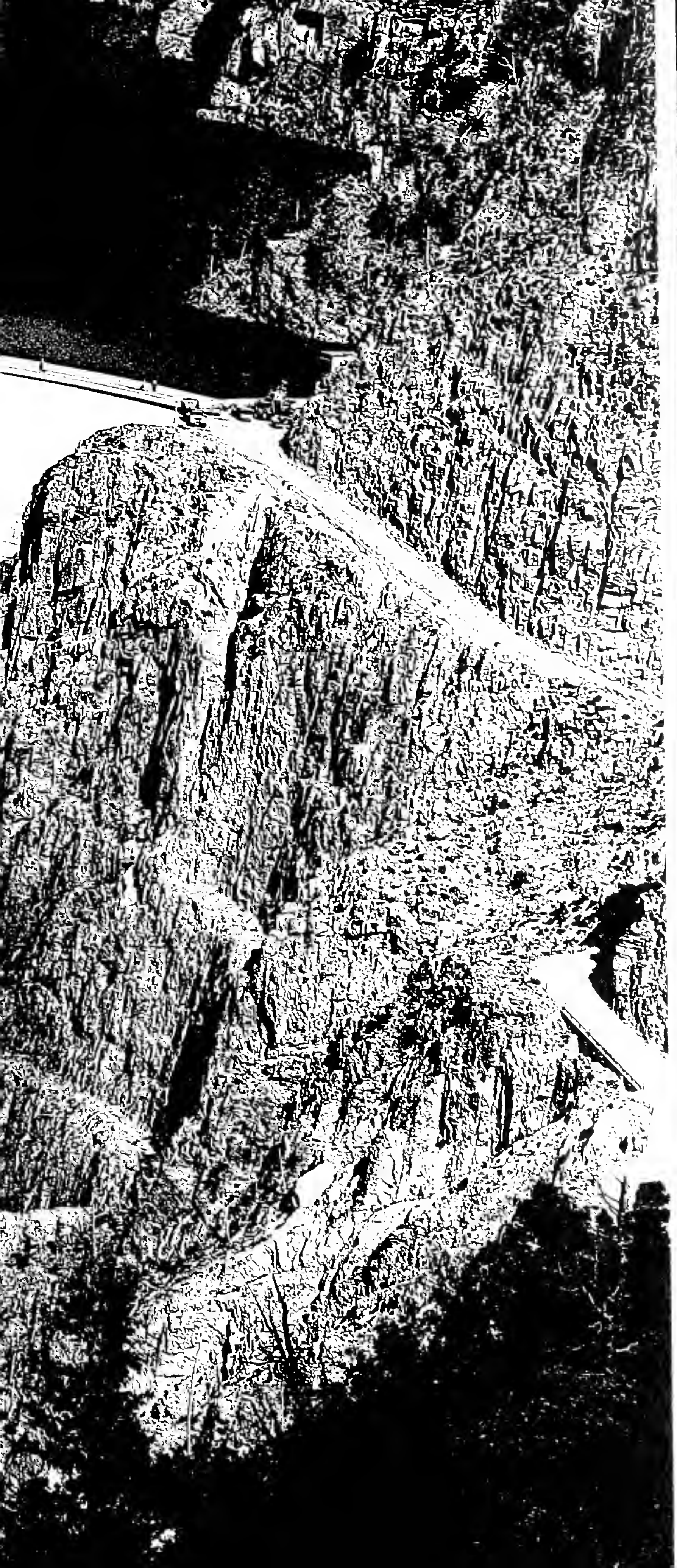
Bureau of Reclamation

November 1991

On the front cover: Panoramic view of Hoover Dam and Lake Mead. Hoover Powerplant, located on the Arizona-Nevada border, has 19 units that supply 1,930 MW of electricity. Hoover Dam changed the once unruly Colorado River into a national resource. Its benefits include protection from floods, river regulation, water conservation for irrigation, municipal and industrial purposes, power generation, recreation, and preservation of fish and wildlife.



Morrow Point Dam in Colorado towers 420 feet high. Located on the Gunnison River, the free-falling spillway creates a spectacular 360-foot waterfall. The powerplant chamber is 231 feet long, 57 feet wide with a height ranging from 65 to 134 feet and is tunneled into the canyon wall about 400 feet below the ground surface. There are two 60 - MW generators.

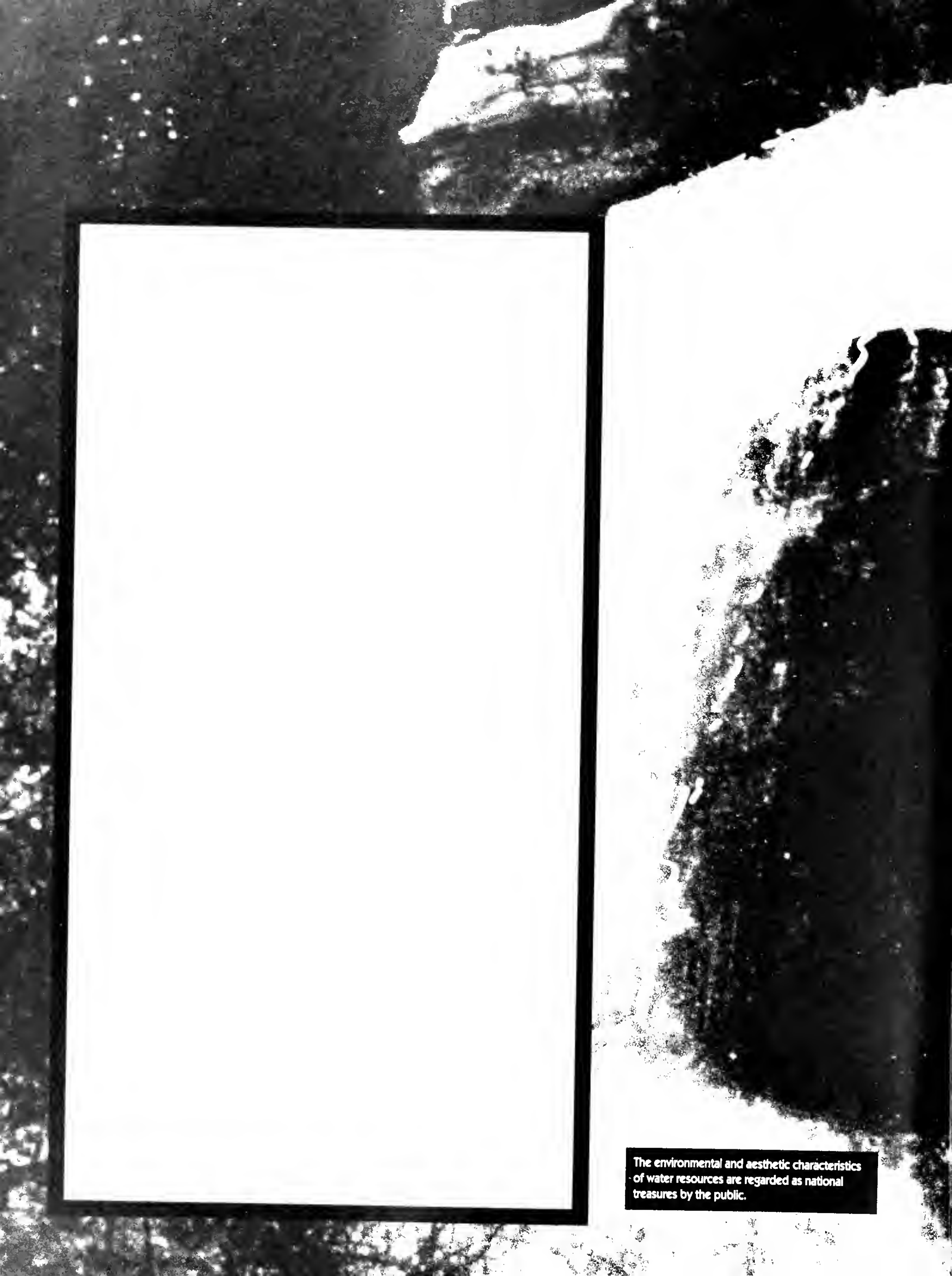


The President's Charter

On July 26, 1989, President Bush directed the Secretary of Energy to initiate the development of a comprehensive National Energy Strategy. He stated:

> *"We cannot and will not wait for the next energy crisis to force us to respond.*
>
> *"Our task—our bipartisan task—is to build the national consensus necessary to support this strategy and to make this strategy a living and dynamic document, responsive to new knowledge and new ideas, and to global, environmental, and international changes.*
>
> *"A keystone of this strategy is going to be the continuation of the successful policy of market reliance. And it's not going to be easy. We must balance—achieve balance—our increasing need for energy at reasonable prices, our commitment to a safer and healthier environment, our determination to maintain an economy that is second to none, and our goal to reduce dependence by ourselves and our friends and allies on potentially unreliable energy suppliers.*
>
> *"I am confident that America's can-do attitude and scientific know-how and old fashioned plain common sense will prevail. By acting now, we can bequeath a legacy to the next century of a cleaner, more prosperous and, yes, more secure America."*

President George Bush
The White House
July 26, 1989



The environmental and aesthetic characteristics of water resources are regarded as national treasures by the public.

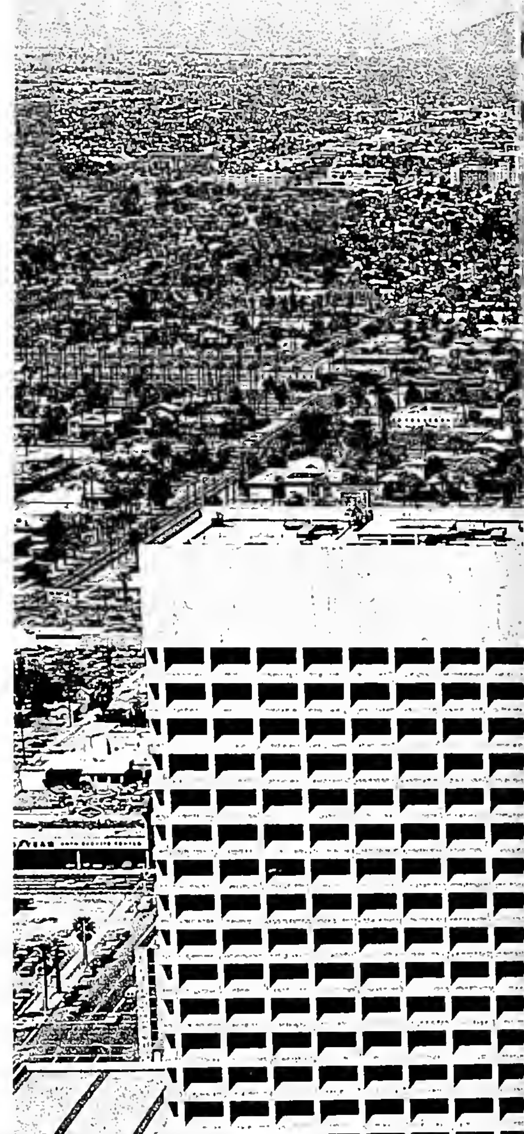
Executive Summary

Reclamation's Energy Initiative

The Bureau of Reclamation can help the Nation meet its present and future energy needs in an environmentally acceptable manner through improvements in hydropower projects and effective management. Existing hydropower projects can be improved and additional hydropower resources can be developed. This report sets forth the strategies that Reclamation will pursue to direct its power program into the 21st century. This is a dynamic document that will be supplemented and updated as new information and technology become available.

Taking a leadership role in supporting our national energy strategy.

Dams provide power and water for many western cities, such as the rapidly growing metropolis of Phoenix, Arizona.



The Importance of Hydropower to the Nation's Energy Supply

Hydropower development has been made possible by using one of our most valuable renewable resources — water. Hydropower has played an important role in the development of this Nation's electric power industry. Both small and large hydropower developments were instrumental during the early expansion of the electric power industry. Recently, increasing demands for energy, high and fluctuating oil prices, and a national desire to reduce dependency on unreliable energy supplies have caused renewed interest in hydroelectric energy resources.

Hydropower enjoys several advantages over most other sources of electrical power. These include a high level of reliability, very low operating costs, and the ability to easily adjust to load changes. Also, hydropower does not produce waste products that contribute to air quality problems, acid rain, and greenhouse gases. There are environmental problems associated with hydropower, but these can be minimized with careful planning and appropriate operations.

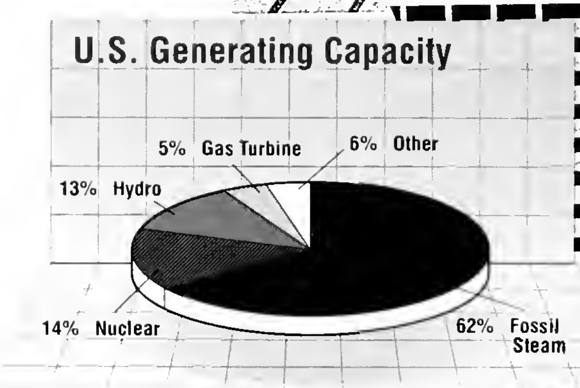
Advantages of Hydropower

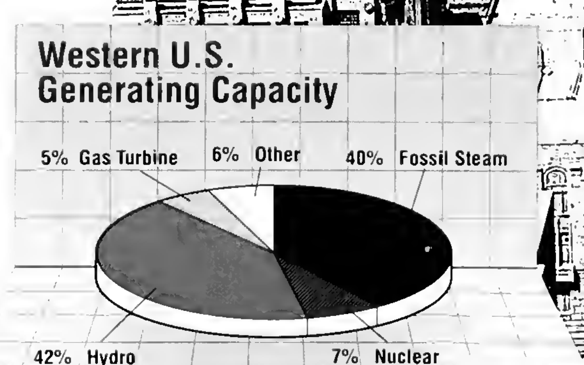
- *Renewable resource*
- *Fuel saver*
- *Flexible to meet load*
- *Efficient*
- *Reliable and durable*
- *Low operation and maintenance costs*
- *Proven technology*
- *No atmospheric pollutants*

Disadvantages of Hydropower

- *High initial cost of facilities*
- *Precipitation dependent*
- *Changes in stream regimens*
- *Inundation of land and wildlife habitat*

Hydroelectric powerplants supply about 13 percent—87,200 megawatts (MW)— of the electric generating capacity in the United States. Nationally, hydroelectric generating capacity is about the same as nuclear power. In the Western United States, hydropower plays a much more important role because 42 percent of all electricity generated comes from hydropower.



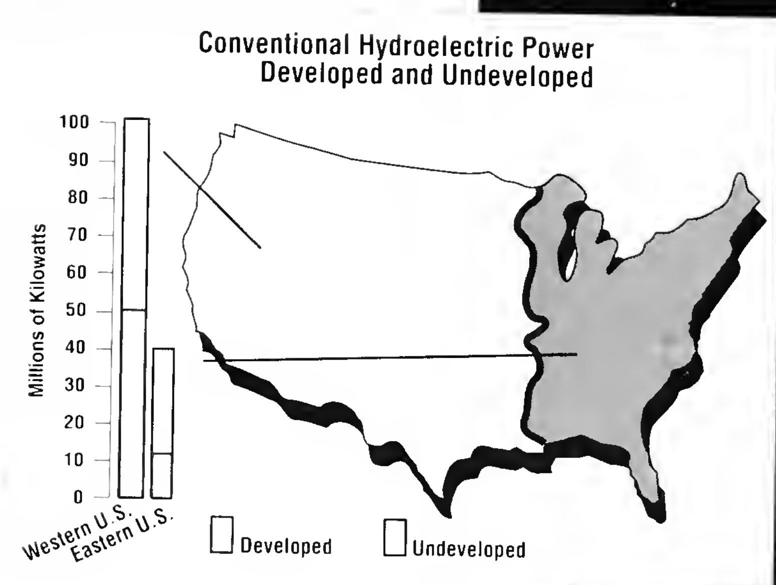



SHOPS

Reclamation is committed to making clean, efficient electricity a part of the future. The health of our environment depends on it. (Snowy Egret along Wolfren Road Ditch, California)

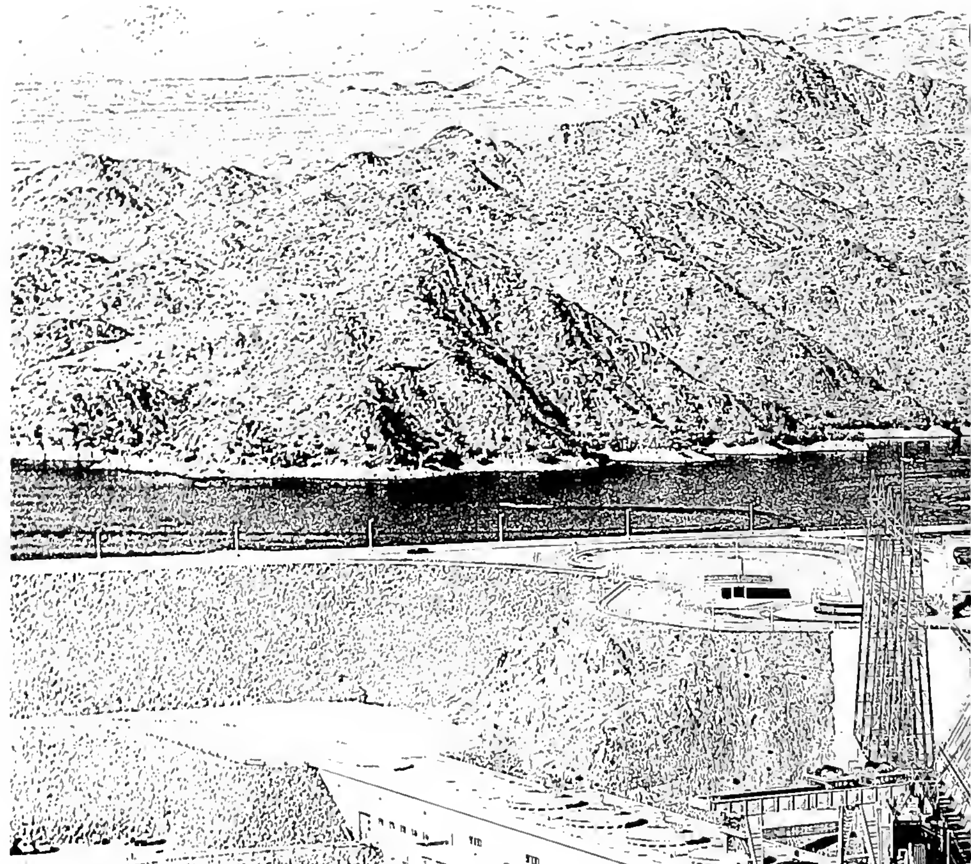
Hydropower represents nearly 90 percent of the capacity contributed by all renewable energy technologies currently used in producing electricity in the Nation.

Most of the Nation's additional future energy needs will mirror its population growth. The majority of recent population growth has occurred in the West, a trend that is expected to continue in the foreseeable future. Planned capacity resources in the United States will be insufficient to meet future energy needs unless additional capacity commitments are made.



Studies by various groups indicate that many potential sites exist for conventional, pumped-storage, and low-head hydroelectric generation. The Federal Energy Regulatory Commission estimated the total potential for additional conventional hydropower development in the United States at 74,700 MW as of January 1, 1988. Of this, 50,400 MW of potential capacity are located in the 17 Western States. If all potential sites could be developed, hydroelectric generating capacity would nearly double.

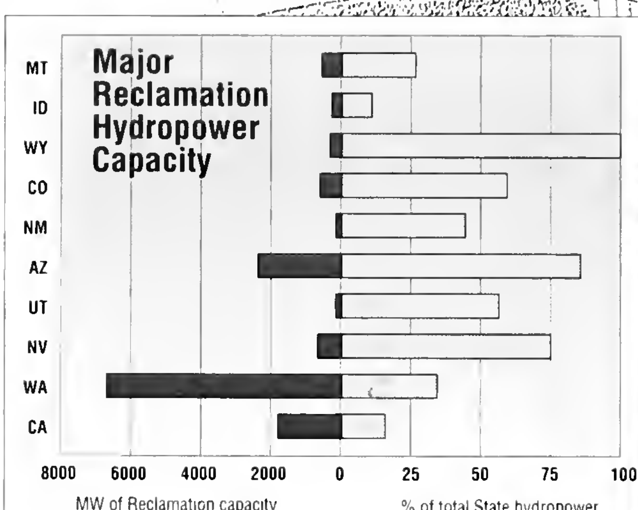
Increasing the generating capacity and energy production at existing hydroelectric powerplants is also critical. Increases can be accomplished through uprates and improved efficiencies. Uprating hydroelectric generator and turbine units at existing powerplants is one of the most immediate, cost-effective, and acceptable means of developing additional electric power. For instance, a 1-percent efficiency improvement in Reclamation hydroelectric powerplants could increase annual generation by 600 million kilowatthours (kWh) and would provide more than $45 million in annual benefits to our Nation.

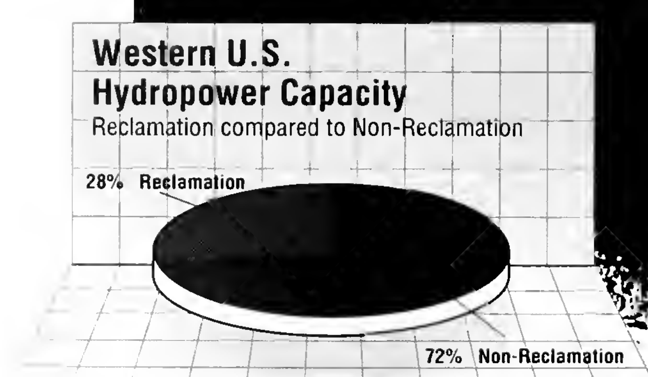


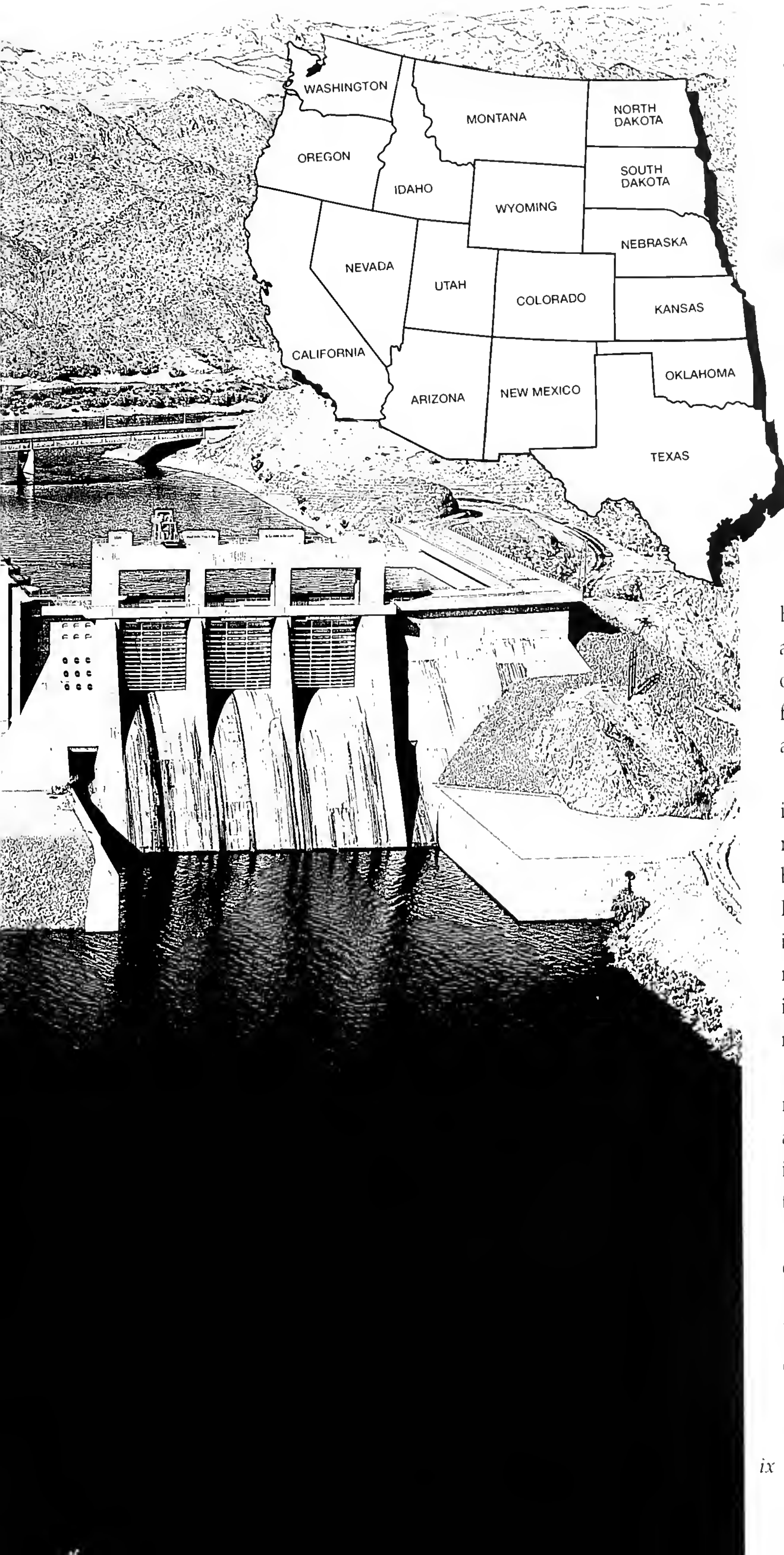
Aerial view showing Davis Dam and Lake Mohave. The electrical integration and interconnection of Reclamation's Davis, Hoover, and Parker Powerplants provide maximum generation of power with efficient use of water resources. The highly developed agricultural base and the complex industrialization of the Pacific Southwest benefit greatly from Colorado River hydroelectric energy.

Reclamation's Leadership Role in Hydropower

Reclamation is one of the Nation's **major producers of electric power.** When compared with the Nation's utilities, Reclamation ranks as the 11th largest in the United States. Reclamation has 52 powerplants in operation with an installed capacity of nearly 14,000 MW. This represents about 16 percent of the Nation's hydropower. In the Western United States, Reclamation powerplants supply more than one-fourth of the current amount of hydropower capacity. Most of Reclamation's hydropower capacity is located in Arizona, Washington, and California. Reclamation provides more than 50 percent of all hydropower capacity in Wyoming, Colorado, Arizona, Utah, and Nevada.







States served by the Bureau of Reclamation.

Financing and cost recovery activities are integral parts of Reclamation's program responsibilities.

Since the inception of the Reclamation program in 1902, more than $16 billion have been invested in water resource and hydropower facilities. Hoover, Grand Coulee, Shasta, and Glen Canyon Dams — some of the largest hydroelectric powerplants in the world — are among the 52 powerplants built and operated by Reclamation with Federal funding and in cooperation with water and power users.

The operational and physical integrity of the multi-billion-dollar investment in Reclamation power projects must be protected and maintained. Under Reclamation law, much of the capital investment in project facilities must be repaid by project beneficiaries, thus requiring diligence in carrying out cost recovery responsibilities.

Revenues from the sale of Reclamation power total about $700 million annually. These revenues have repaid, including aid to irrigation, over $6 billion to the Federal Treasury.

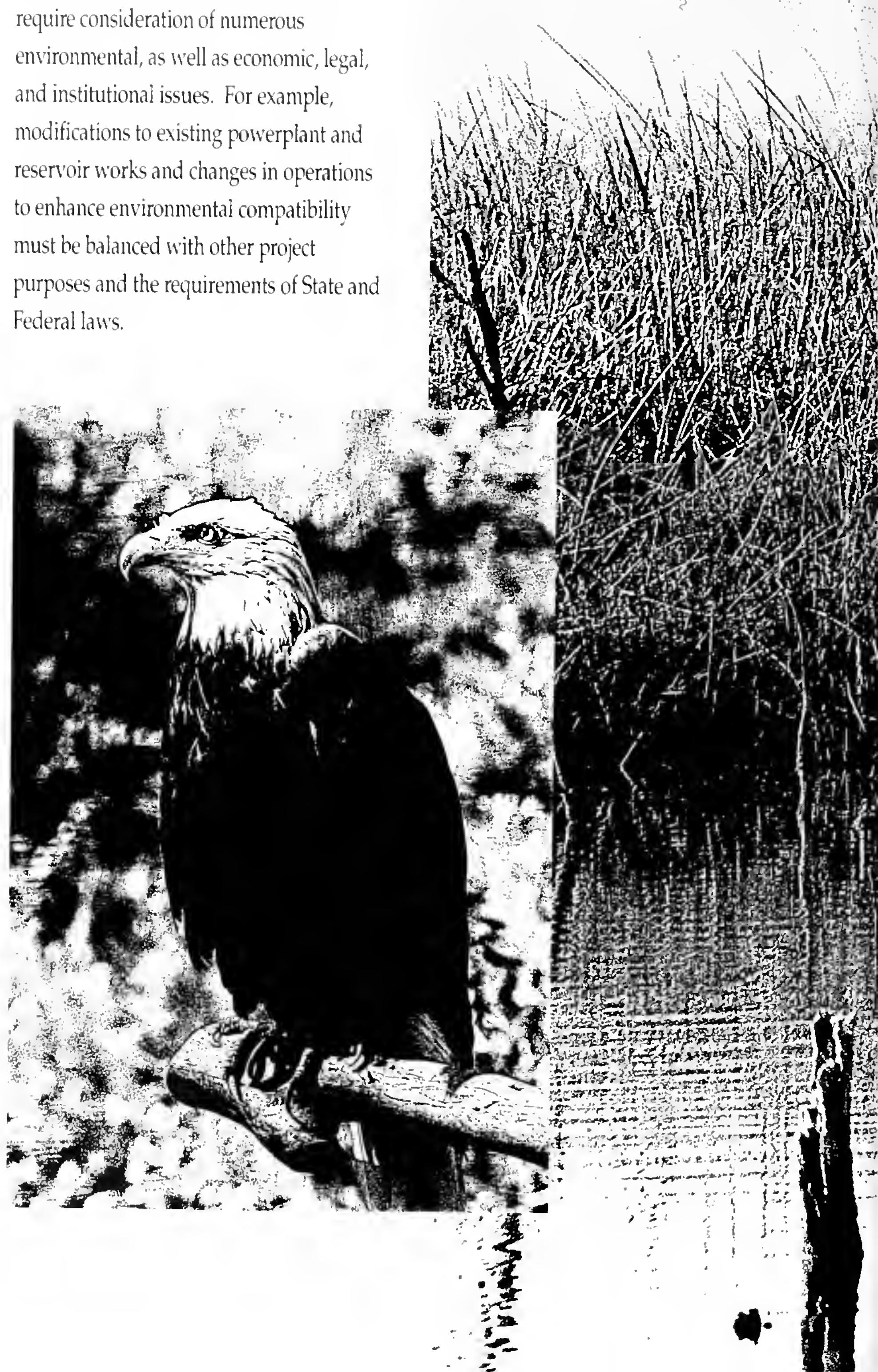
Reclamation will strengthen its existing programs and develop new financing and cost recovery initiatives to help meet the Nation's energy and related economic and environmental needs.

A principal consideration of hydropower today is the careful balancing of environmental values and development benefits.

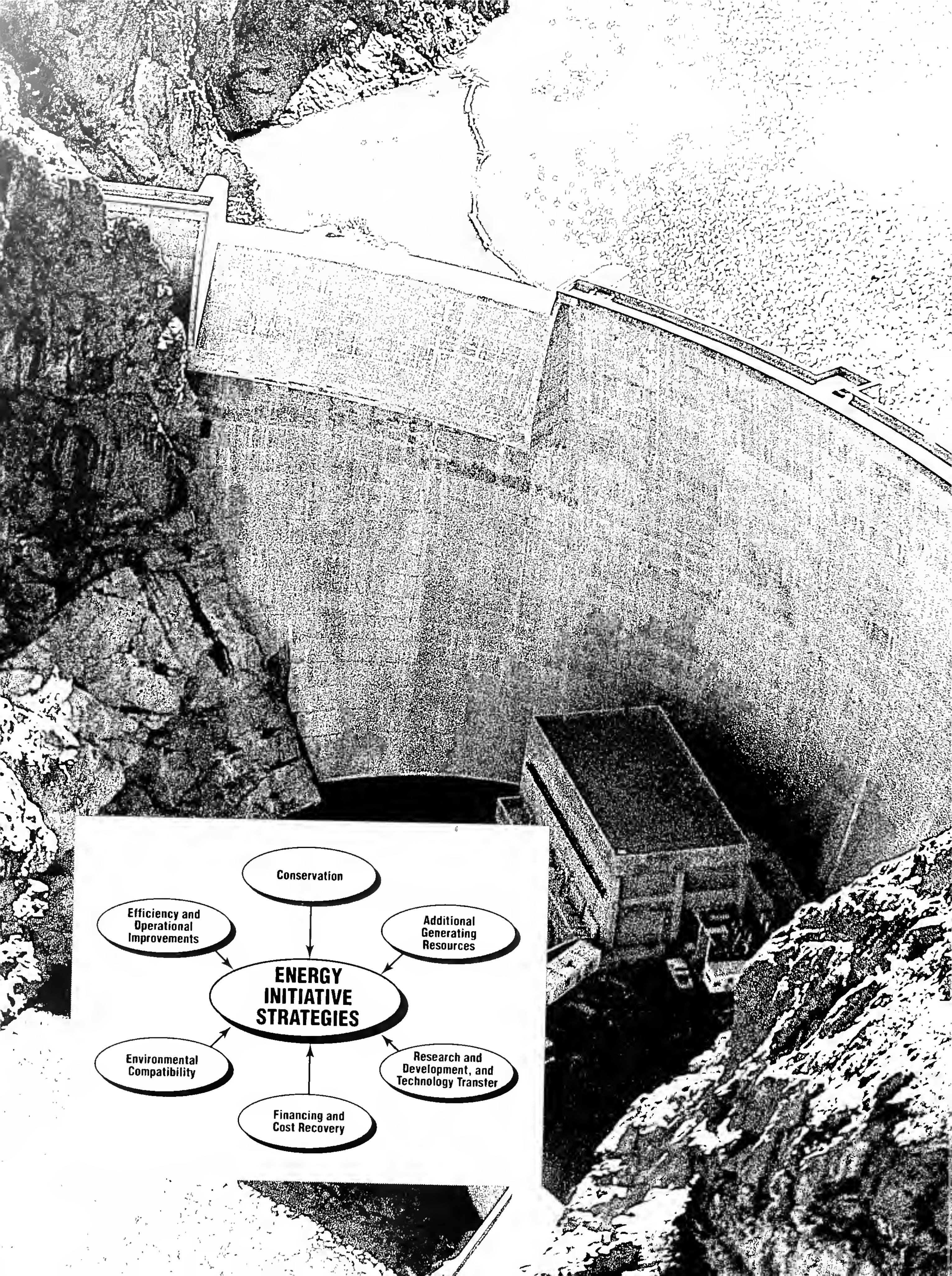
Environmental Considerations

A key challenge for Reclamation is to improve environmental compatibility of existing and new hydropower developments while increasing hydropower's contribution to meeting the Nation's energy supply needs.

Operating existing hydropower facilities and developing new facilities require consideration of numerous environmental, as well as economic, legal, and institutional issues. For example, modifications to existing powerplant and reservoir works and changes in operations to enhance environmental compatibility must be balanced with other project purposes and the requirements of State and Federal laws.



Reclamation administers 8.6 million acres of public land in the 17 Western States. Conservation and environmental protection of these lands must be balanced with basic power and water needs.


Conservation
Efficiency and Operational Improvements
Additional Generating Resources
ENERGY INITIATIVE STRATEGIES
Environmental Compatibility
Research and Development, and Technology Transfer
Financing and Cost Recovery

Aerial photo of Crystal Dam and Reservoir on the Gunnison River in Colorado. Crystal Powerplant is part of the Wayne N. Aspinall Storage Unit which developed the water storage and hydroelectric power generating potential along a 40-mile section of the Gunnison River. The 28-MW generator began operating in June 1978.

Hydropower 2002

Reclamation's Energy Initiative

Reclamation's hydropower program activities are based on an assessment of opportunities which recognizes technical, environmental, financial, legal, and institutional considerations.

Reclamation's Energy Initiative, *HYDROPOWER 2002*, consists of the following strategies:

Efficiency and Operational Improvements

- Improve hydropower plant reliability. Needed improvements in existing operating plants, including operation and maintenance procedures, will be evaluated to improve plant performance. Continue an effective preventive maintenance program to lower maintenance costs and increase productivity.
- Rehabilitate existing powerplants, where economically justified and environmentally acceptable.
- Investigate and improve automation and/or remote control of hydropower plants to provide reliable, efficient operation; on-line diagnostics; environmental data collection; and report generation.
- Optimize the operation of Reclamation powerplants in an environmentally and financially sound manner to benefit both power system participants and the Federal government, consistent with State and Federal laws.
- Increase efforts to develop and renovate computer systems that enhance power generation in each multiunit plant and in a series or system of plants.
- Pursue broad interregional coordination and interconnection of power sources to achieve greater economy, reliability, and optimal use of the Nation's hydroelectric power supply.
- Undertake periodic energy program audits to ensure Reclamation's hydropower facilities are effectively and efficiently operated and maintained.

Hydropower facilities, unlike other electric generating facilities, are multiple-use projects. Benefits include not only clean, secure, reliable electricity, but also flood control, water supplies, irrigation, fisheries and wildlife habitat, and recreation.

Develop and implement methods for project water conservation, thereby reducing project energy and water usage.

Modify water scheduling and operations to reduce peak demands for project water and power, where possible.

Reduce in-plant electricity use.

Pursue, in cooperation with others, water and energy demand management to improve conservation and system operations and to reduce peak needs.

Assess the potential to add hydropower plants at existing facilities and enlarge existing Reclamation powerplants, where economically justified and environmentally acceptable.

Develop, where appropriate, the hydropower potential of Reclamation's projects by establishing agreements with the non-Federal sector, by seeking legislation that would authorize Reclamation's participation in a specific development, and by granting leases of power privilege for hydropower development at Reclamation projects.

Assess the opportunities for potential non-Federal or cost shared development of additional conventional, pumped-storage, and low-head hydroelectric generation; other renewable energy technologies; and energy storage systems for water and power systems owned, managed, or operated by Reclamation.

Promote and support, in coordination with the Department of Energy and others, an aggressive cooperative research and technology transfer program directed at improving conventional, pumped-storage, and low-head hydroelectric generation technology.

Investigate the potential impacts of global climate change on water supply and hydropower production and provide mitigation opportunities to help offset adverse impacts.

Promote and support interregional coordination and cooperation with other Federal, State, and private organizations.

Further water yield enhancement technology development and transfer, from which hydropower would benefit.

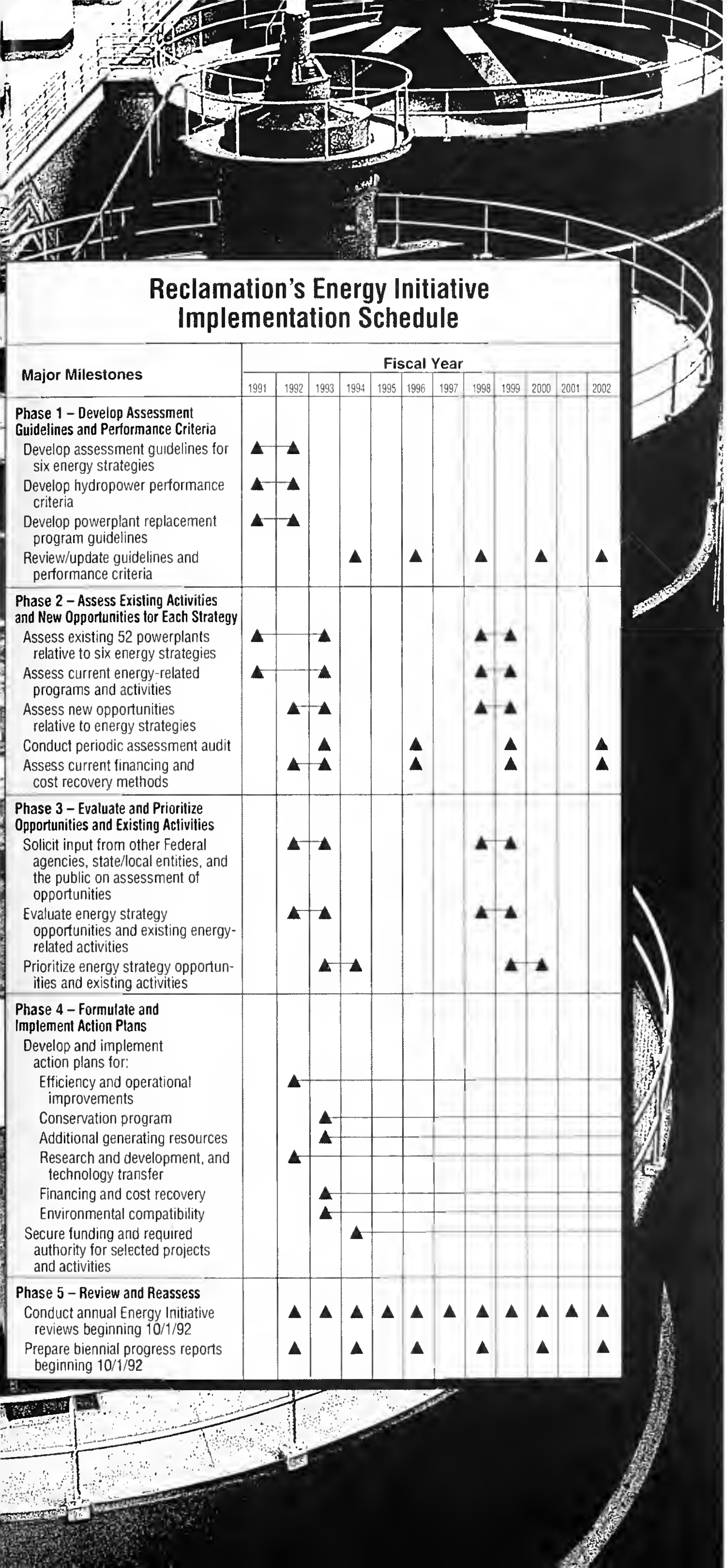
Parker Dam and Powerplant on the Colorado River, Arizona and California border, began initial operation in December 1942. The powerplant was built to provide low-cost electrical energy to Arizona and Southern California. The powerplant has four units with a total capacity of 120 MW.

[illegible] Cost Recovery

- Ensure that sufficient revenues are returned to the Federal Treasury to recover the cost of investment, recover operation and maintenance expenses, and provide for future replacements.
- Consult and coordinate with applicable Power Marketing Administrations on the financial and budget information needed to meet mutual planning and program responsibilities.
- Ensure that appropriate funds are requested for and dedicated to Reclamation's hydroelectric operation, maintenance, and replacement program and efficiency improvement program.
- Investigate other revenue-enhancing opportunities to expedite repayment of the capital investment to the Federal Treasury.
- Pursue cost-sharing opportunities in all phases of Reclamation's power program, including planning, uprating, development, operation and maintenance, system improvements, research, and conservation.

Environmental Compatibility

- Assess the impact Reclamation's hydropower facilities are having on the environment.
- Develop, and implement where appropriate, environmental action plans that help mitigate or minimize environmental problems caused by Reclamation's facilities and operations.
- Encourage and carry out research to develop new technologies or operational scenarios that help mitigate or minimize the adverse environmental impacts of hydropower development and operations.
- Undertake periodic environmental audits to ensure that Reclamation's hydropower facilities are being operated in an environmentally acceptable manner and that previous commitments are being met.



Reclamation's Energy Initiative Implementation Schedule

Major Milestones	Fiscal Year 1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Phase 1 – Develop Assessment Guidelines and Performance Criteria												
Develop assessment guidelines for six energy strategies	▲	▲										
Develop hydropower performance criteria	▲	▲										
Develop powerplant replacement program guidelines	▲	▲										
Review/update guidelines and performance criteria				▲		▲		▲		▲		▲
Phase 2 – Assess Existing Activities and New Opportunities for Each Strategy												
Assess existing 52 powerplants relative to six energy strategies	▲		▲					▲	▲			
Assess current energy-related programs and activities	▲		▲					▲	▲			
Assess new opportunities relative to energy strategies		▲	▲					▲	▲			
Conduct periodic assessment audit			▲			▲			▲			▲
Assess current financing and cost recovery methods		▲	▲			▲			▲			▲
Phase 3 – Evaluate and Prioritize Opportunities and Existing Activities												
Solicit input from other Federal agencies, state/local entities, and the public on assessment of opportunities		▲	▲					▲	▲			
Evaluate energy strategy opportunities and existing energy-related activities		▲	▲					▲	▲			
Prioritize energy strategy opportunities and existing activities			▲	▲					▲	▲		
Phase 4 – Formulate and Implement Action Plans												
Develop and implement action plans for:												
Efficiency and operational improvements		▲	—	—	—	—	—	—	—	—	—	—
Conservation program			▲	—	—	—	—	—	—	—	—	—
Additional generating resources			▲	—	—	—	—	—	—	—	—	—
Research and development, and technology transfer		▲	—	—	—	—	—	—	—	—	—	—
Financing and cost recovery			▲	—	—	—	—	—	—	—	—	—
Environmental compatibility			▲	—	—	—	—	—	—	—	—	—
Secure funding and required authority for selected projects and activities				▲	—	—	—	—	—	—	—	—
Phase 5 – Review and Reassess												
Conduct annual Energy Initiative reviews beginning 10/1/92		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Prepare biennial progress reports beginning 10/1/92		▲		▲		▲		▲		▲		▲

Reclamation is fully committed to furthering energy efficiency, conservation and development programs that are environmentally and financially sound. Execution of Reclamation's Energy Initiative will be an ongoing process that will ensure Reclamation's continued responsiveness to national energy and related economic and environmental needs.

Implementation of Reclamation's Energy Initiative strategies will be accomplished through a five-phase process:

Develop assessment guidelines and performance criteria
Assess existing activities and new opportunities for each strategy
Evaluate and prioritize opportunities and existing activities
Formulate and implement action plans (includes validated ongoing projects and activities)
Review and reassess

This implementation process will serve as a foundation for institutionalizing the Energy Initiative throughout Reclamation by ensuring continual assessment and adjustment of energy-related activities, as necessary.

A schedule has been developed to guide Reclamation's efforts during the next decade.


The Yellowtail Dam and Powerplant in Montana has been in operation since 1966. It is a multi-purpose facility supplying 250 MW of electricity, as well as flood control and irrigation.

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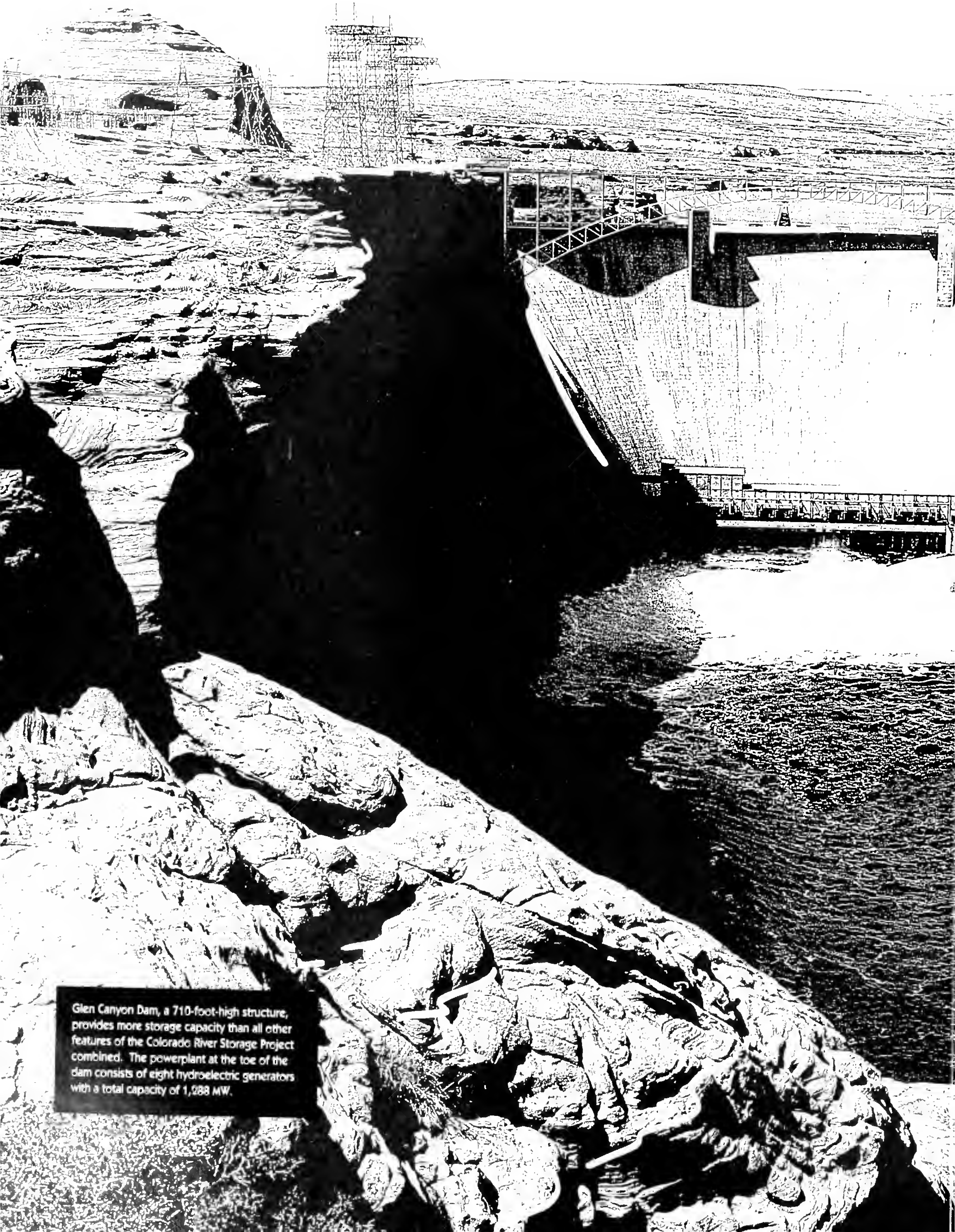
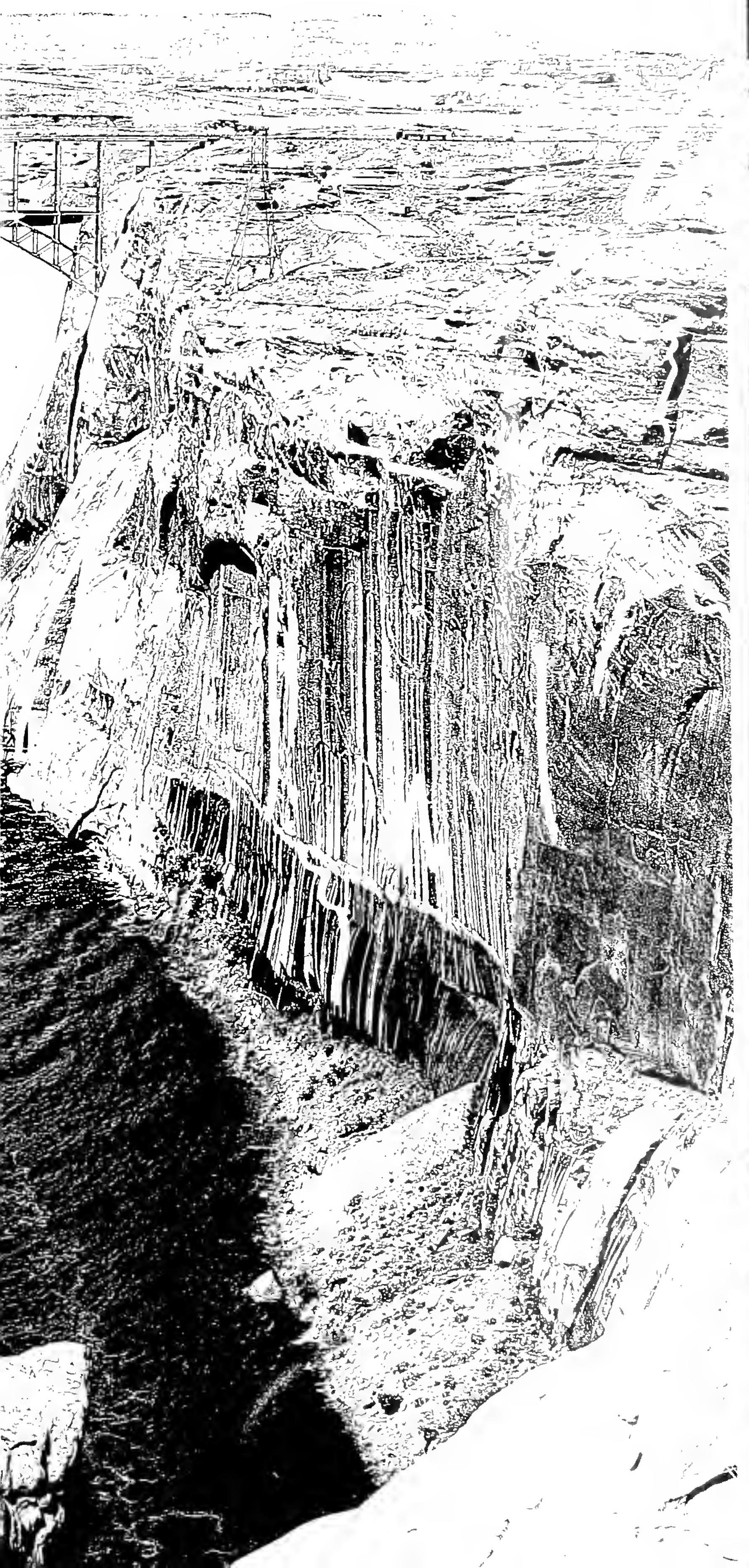


Glen Canyon Dam, a 710-foot-high structure, provides more storage capacity than all other features of the Colorado River Storage Project combined. The powerplant at the toe of the dam consists of eight hydroelectric generators with a total capacity of 1,288 MW.



Chapter One

Hydropower's Role in the Nation's Energy Resources

The National Energy Strategy, as mandated by President Bush in his July 26, 1989, letter to the Secretary of Energy, calls for us, as a Nation, to

> *". . . balance . . . our increasing need for energy at reasonable prices, our commitment to a safer and healthier environment, our determination to maintain an economy that is second to none, and our goal to reduce dependence by ourselves and our friends and allies on potentially unreliable energy supplies."*

The Bureau of Reclamation can help achieve the balance called for by the President.

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

...DERSHIP ROLE IN SUPPORTING OUR NATIONAL ENERGY STRATEGY.

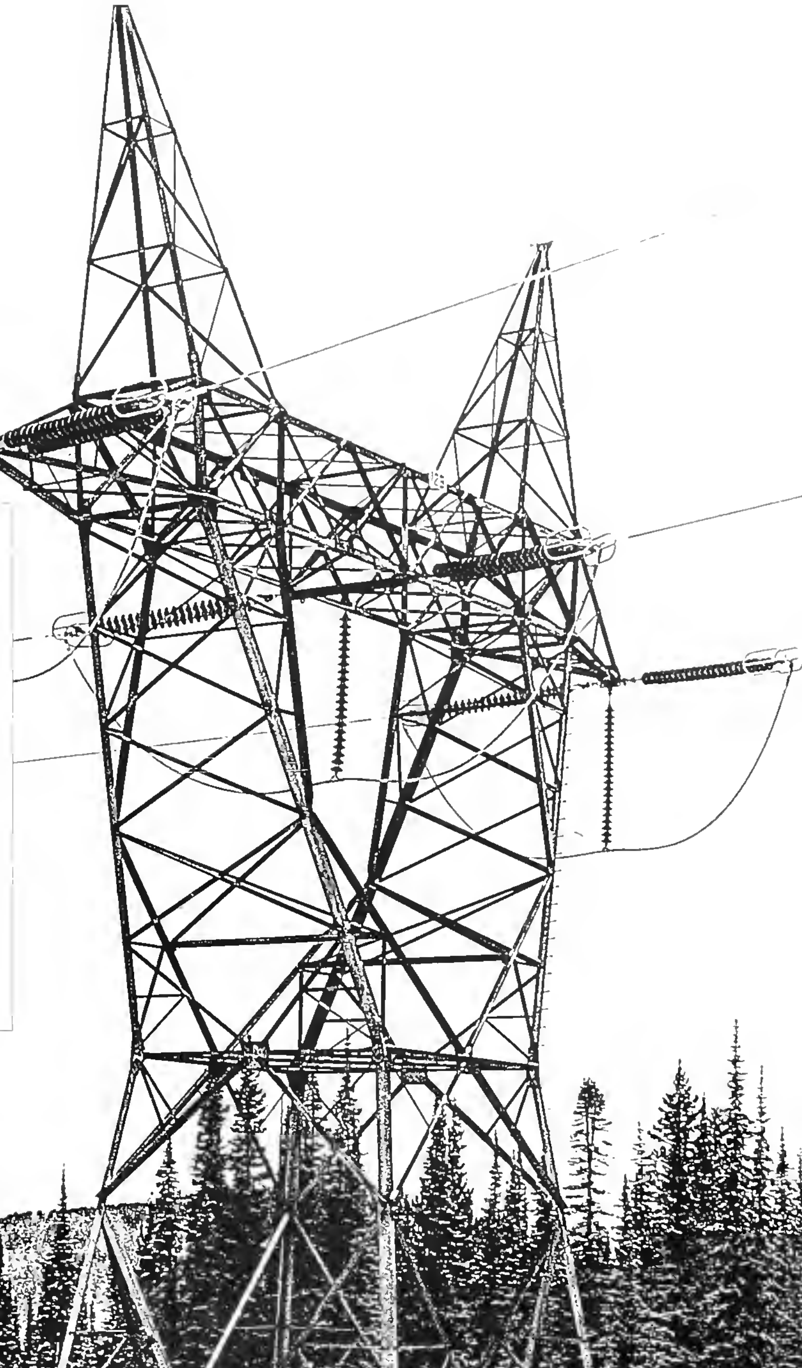
During the past two decades, the United States has experienced several energy crises: fuel shortages in 1972; the oil embargo in 1973-74; coal mine strikes in 1974 and 1977-78; a natural gas shortage during the 1976-77 winter; the gasoline crisis of 1978-79; and the Mideast crisis of 1990-91. Energy price increases associated with these events combined to substantially change the United States energy economy. The United States temporarily reduced the amount of oil imported from foreign sources, and coal and renewable energy became the energy sources of choice.

During this time, utilities experienced financial difficulties. Slower growth in electrical demand resulted in a period of excess capacity in many parts of the country. At the same time, utilities faced increasing opposition to nuclear plants. Some of these plants were canceled at substantial cost to the utilities and the American public. Recently, utilities have been cautious about adding capacity, even though some sources are predicting regional capacity shortfalls in the 1990's.

The North American Electric Reliability Council (NERC) reported a summer peak demand of 523,000 MW in 1989 (the last year for which actual data are available). NERC projects that the summer peak electrical demand in the United States during 1990-99 will increase at an annual rate of 2 percent. NERC also estimates that, at an 80-percent probability level, summer peak demand will increase between 1.2 and 2.7 percent annually. This demand forecast results in a projected 1999 summer peak range of 580,000 to 708,000 MW. The energy growth rates are slightly higher than those for capacity, resulting in higher system annual load factors and increased use of existing and future generation and transmission facilities.

All installed capacity is not available at any given time due to full or partial forced outages, seasonal derating, and maintenance requirements. Therefore, planned capacity resources are reduced and defined as projected available resources, resulting in a more accurate measure of capacity available to meet peak demand. The relationship between projected available resources and projected peak demand (less load management and interruptible demand) is shown in Figure 1.1.

Interconnections permit utilities to share generation to improve reliability, economics, and efficiency, and allow neighboring utilities to help each other during emergencies. Reclamation-generated power is marketed and transported by the Western Area Power Administration and the Bonneville Power Administration.



Planned capacity resources in the United States could be insufficient by 1999 unless additional capacity commitments are made. If peak demand growth approaches the 2.7-percent rate, deficiencies could be reached earlier than 1999 in certain

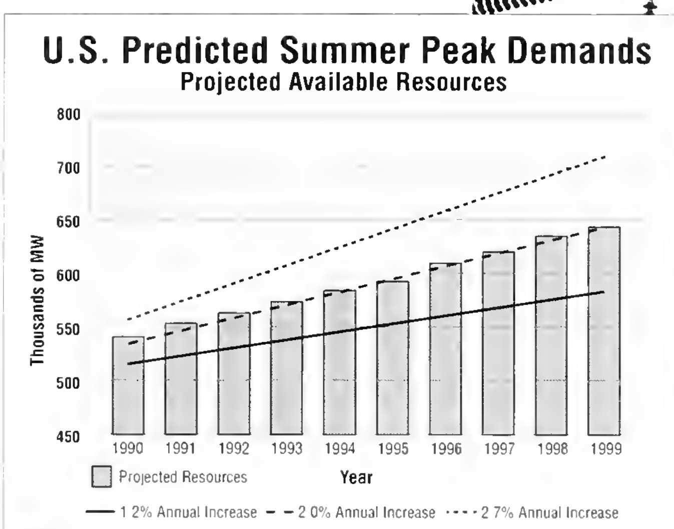


Figure 1.1

areas. Of the 86,200 MW of planned capacity additions for the United States during the 1990-99 period, only 3,700 MW represent hydropower. This is 4.3 percent of the planned capacity additions. Figure 1.2 shows the capacity additions by type that are planned during the 10-year period.

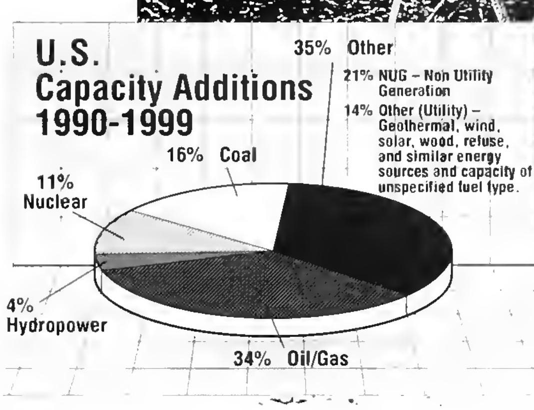
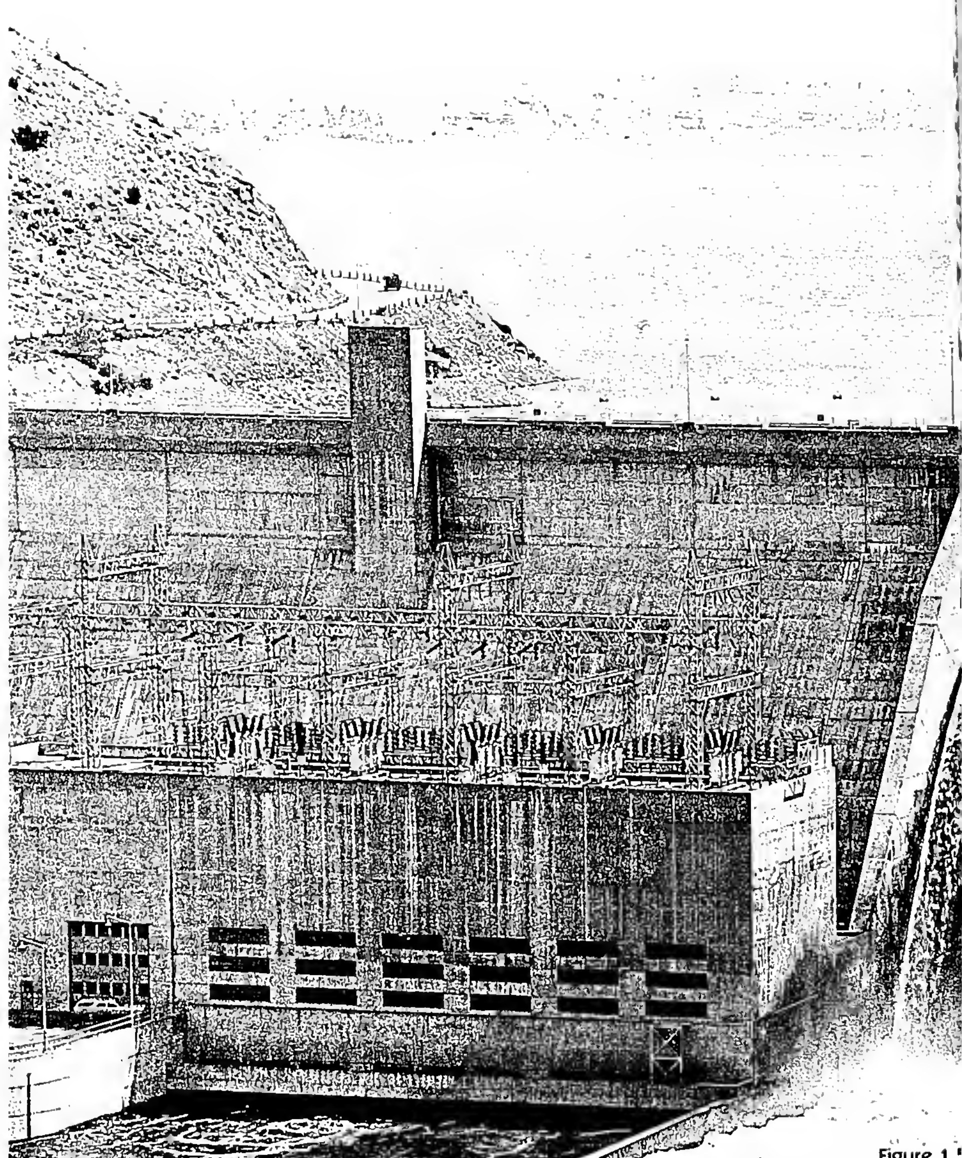


Figure 1.2

Canyon Ferry Dam and Powerplant on Montana's Missouri River began operation in December 1953. The three generator units have a combined rating of 50 MW. Dikes built at the upper end of the reservoir supply important waterfowl habitat.

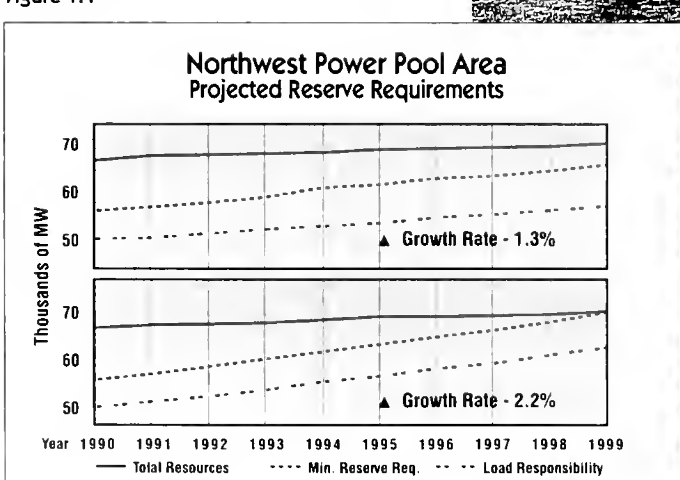


Projected Capacity in the Western United States

The Western United States is represented by the Western Systems Coordinating Council (WSCC), of which Reclamation is a member (see Figure 1.3). The average annual compound growth forecasts average 1.9 percent for the next 10 years. Net generation additions are projected to be 14,287 MW.

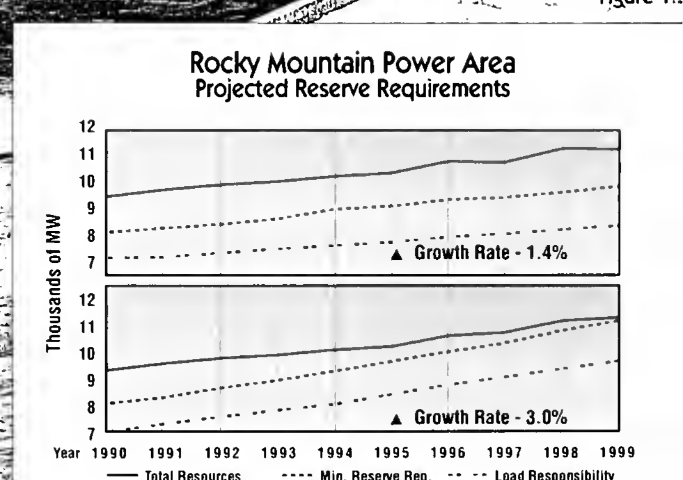
Utilities in the region represented by WSCC are making plans so that sufficient replacements and additional capacity can be provided to meet the 1.9-percent increase forecasted for the overall region. However, because actual peak demands in many regions have been consistently and substantially higher than forecast, capacity shortfalls may occur in some areas within the next 10 years if demand grows at a rate higher than

Figure 1.4



Projected 10-Yr Load Responsibility growth rate is 1.3%.
If load responsibility increased 2.2% per year instead of 1.3%, surplus reserve margin would disappear by 1999.

Figure 1.5



Projected 10-Yr Load Responsibility growth rate is 1.4%.
If load responsibility increased 3.0% per year instead of 1.4%, surplus reserve margin would disappear by 1999.

Figure 1.3

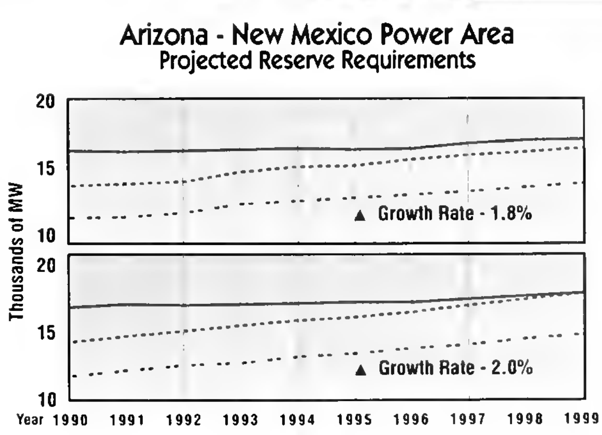
Western Systems Coordinating Council General Load Areas

- I Northwest Power Pool Area
- II Rocky Mountain Power Area
- III Arizona-New Mexico Power Area
- IV California-So. Nevada Power Area

forecast for the specific area. This is evidenced by the projected resources and loads for each of the four areas within WSCC. As shown in Figures 1.4 through 1.7, if the growth rate exceeds 2 percent in some areas and 3 percent in others, there will be an inadequate reserve margin before 1999.

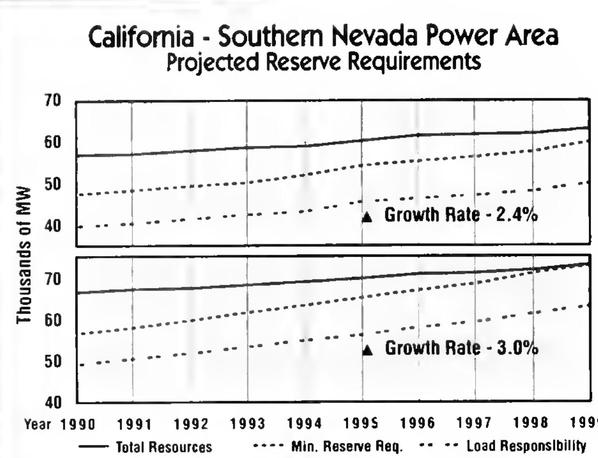
Even given the difficulties of forecasting electrical demand, it is clear that significant additional supply will be needed in the future. Therefore, the United States must have available all economic and environmentally acceptable options for generating electricity identified and prioritized for implementation.

gure 1.6



Projected 10-Yr Load Responsibility growth rate is 1.8%.
If load responsibility increased 2.0% per year instead of 1.8%, surplus reserve margin would disappear by 1999.

Figure 1.7



Projected 10-Yr Load Responsibility growth rate is 2.4%.
If load responsibility increased 3.0% per year instead of 2.4%, surplus reserve margin would disappear by 1999.

Hydropower accounts for about 13 percent of the Nation's generating capacity (Figure 1.8). Nuclear generating accounts for slightly more — 14 percent. Fossil steam accounts for the most generating capacity—62 percent.

By some estimates, the amount of undeveloped hydropower potential in the United States exceeds the current installed hydropower capacity of 87,200 MW. The Department of Energy (DOE) is currently conducting a Hydropower Resource Assessment Evaluation to determine the undeveloped potential. This evaluation includes information and support from the Power Marketing Administrations, Energy Information Administration, Federal Energy Regulatory Commission, Tennessee Valley Authority, Bureau of Reclamation, Corps of Engineers, Idaho National Engineering Laboratory, and Oak Ridge National Laboratory.

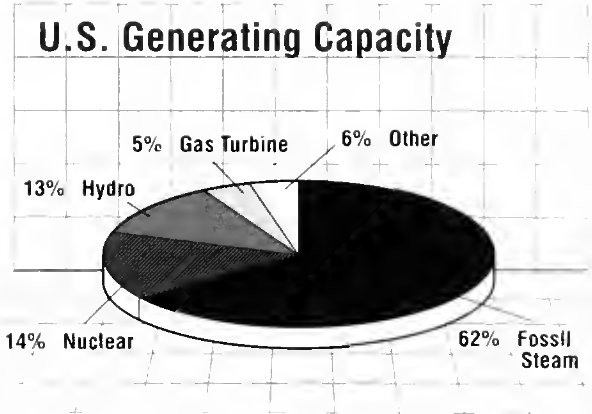
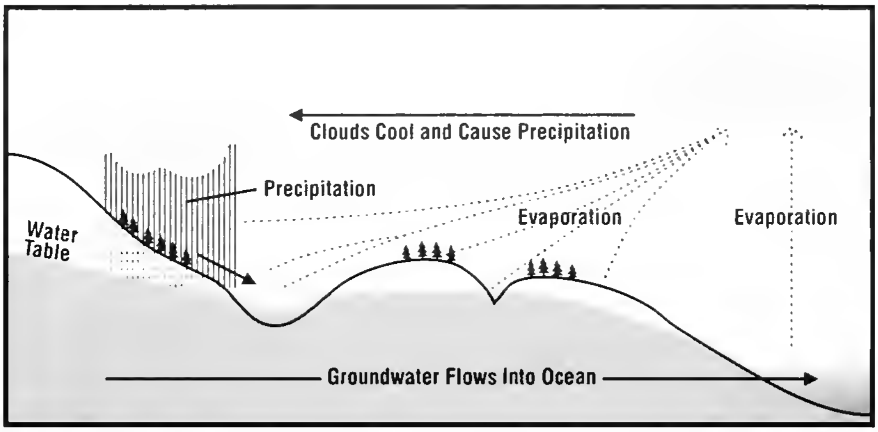


Figure 1.8



Hydroelectric power is a renewable energy resource powered by the hydrologic cycle.

The unique nature of hydropower provides many advantages over other electrical power sources.

Hydroelectric facilities are the most efficient energy-producing plants. Hydroelectric powerplants operate at 85- to 90-percent efficiency, more than twice that of fossil-fueled plants.

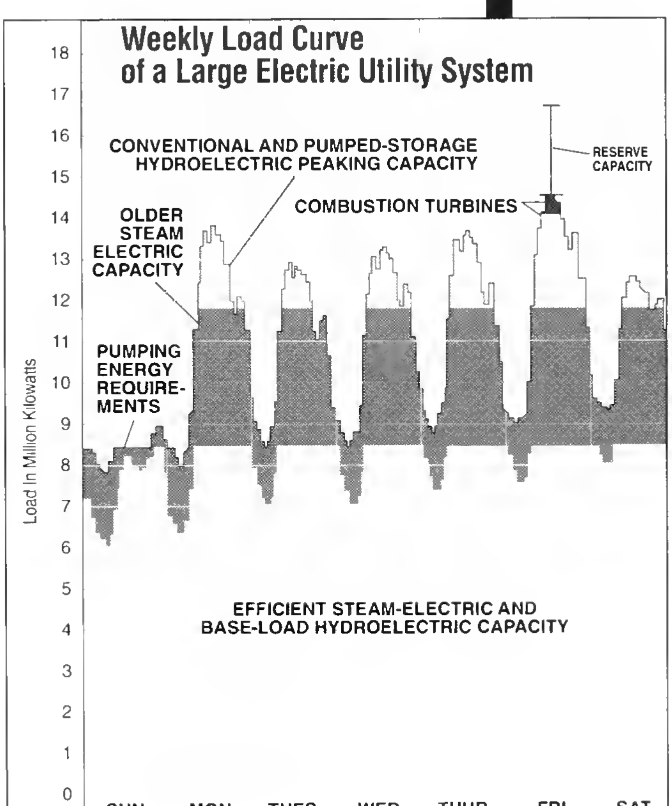
Hydroelectric powerplants can save fossil fuel. As new hydroelectric projects are brought online, inefficient fossil-fuel plants can be retired and new ones can be deferred.

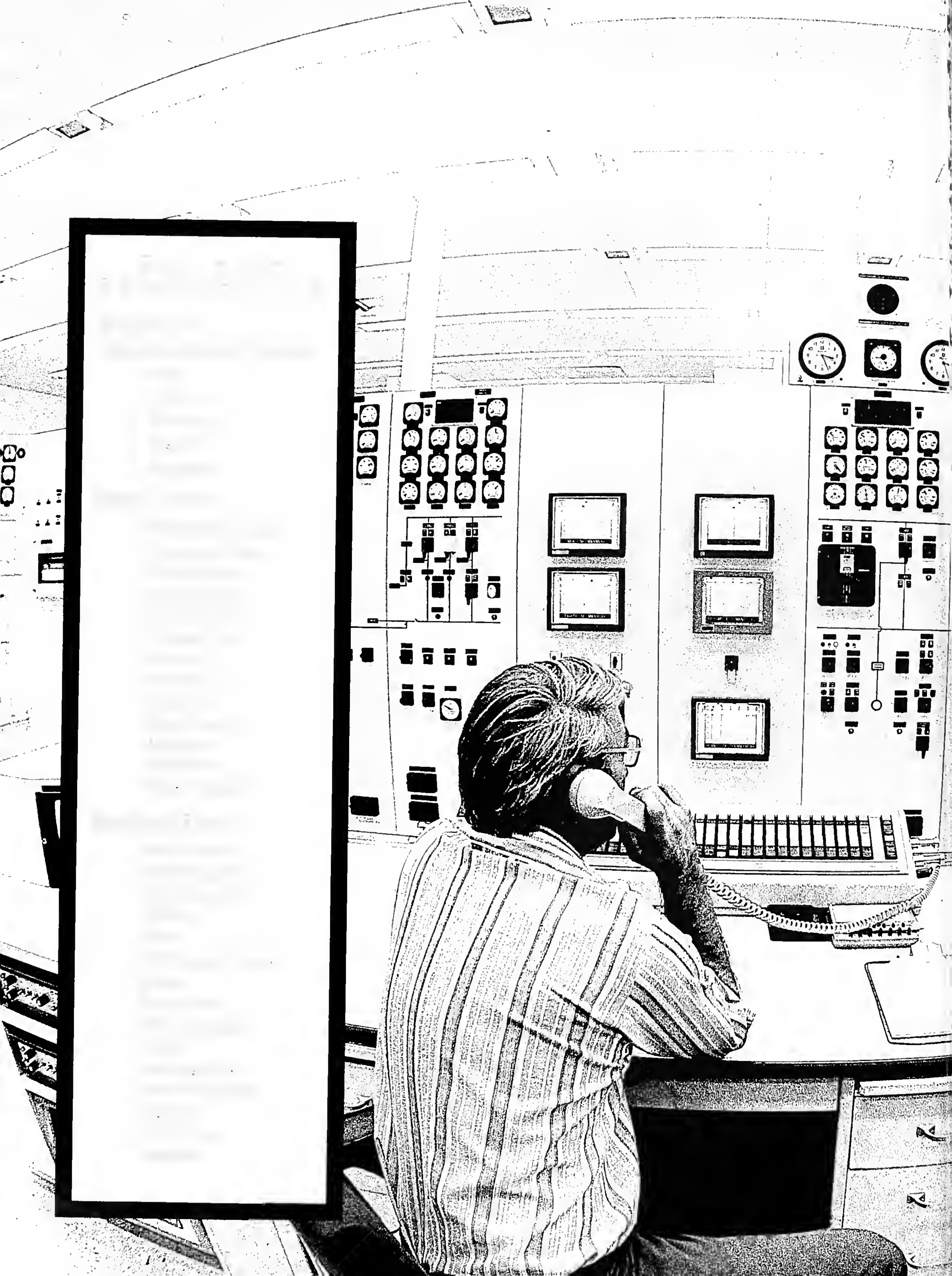
Hydroelectric powerplants are flexible in meeting peak power demands. Hydroelectric projects can adjust to load changes quickly. Also, reservoirs to store water for hydroelectric power are the best large-scale means for storing electrical energy.

Hydroelectric powerplants are reliable and durable. The machinery involved has relatively few moving parts. Because excessive heat is not produced, cycling has a minimal effect on machinery, which contributes to long life and low maintenance. Unplanned outage rates for hydroelectric units are the lowest in the electric industry.

Hydroelectric powerplants are relatively inexpensive to operate because there are no fuel costs. This accounts for the inflation-proof label often given to hydroelectric power.

Thermal, chemical, radioactive, water, and air pollution are minimized by hydropower generation as compared to coal and nuclear power, which produce substantial quantities of residual wastes. Coal-fired generation contributes to acid rain and increases in greenhouse gases.





Main Control Room in Davis Dam Powerplant, a 5-unit, 240-MW plant on the Colorado River that began operation in 1951. The Mexican Treaty of 1944 required the United States to construct Davis Dam for regulation of water to be delivered to Mexico.

As with any energy source, hydropower has certain disadvantages.

- Building a new dam and a hydroelectric powerplant contribute to high capital cost.
- Output of electricity from a hydroelectric powerplant can fluctuate seasonally, depending on streamflow, unless sufficient water is stored behind a dam. Without an assured output at all times, the value of the powerplant to a utility system is diminished.
- Hydroelectric powerplants can adversely affect the quantity and quality of river flows. The river system can be altered during construction of a powerplant and by its mode of operation in generating electric power.
- If a large storage reservoir is involved, substantial land area and riverine habitat are inundated.

Coordination activities and day-to-day contacts with other Federal agencies and public and private electrical energy interests are an extensive and integral part of Reclamation's power program. Reclamation must maintain a strong and close working relationship with organizations involved in the power industry to ensure the best use and coordination of Reclamation hydropower resources.

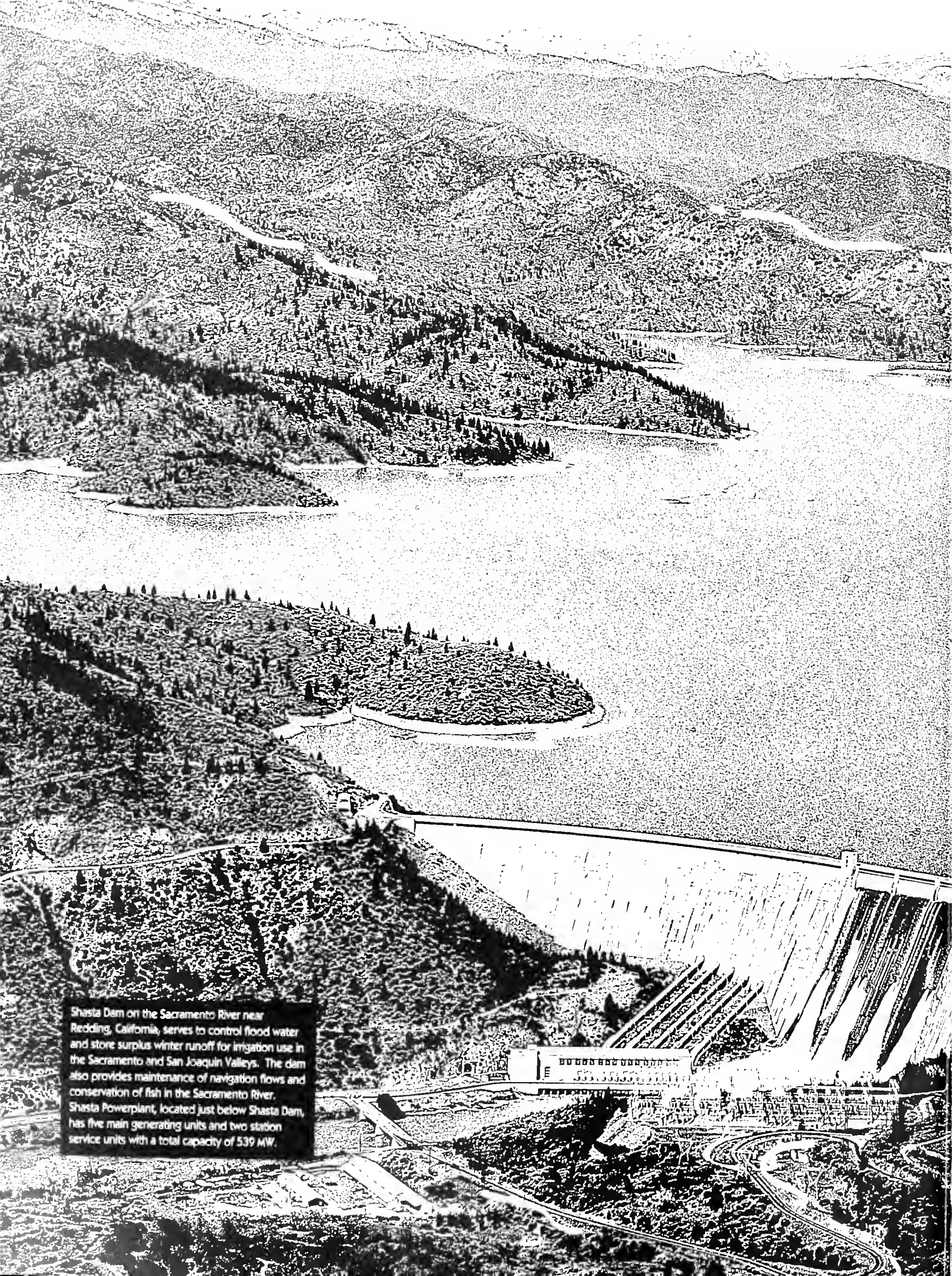
Differences in regional capacities and continuing growth in electrical demand increase the desirability of regional and interregional coordination. Broad interregional coordination can contribute to greater economy and reliability of the Nation's electric power supply and provide for optimum use of hydroelectric power resources.

Coordination of planning and operation results in many benefits. Less installed capacity may be needed because of:

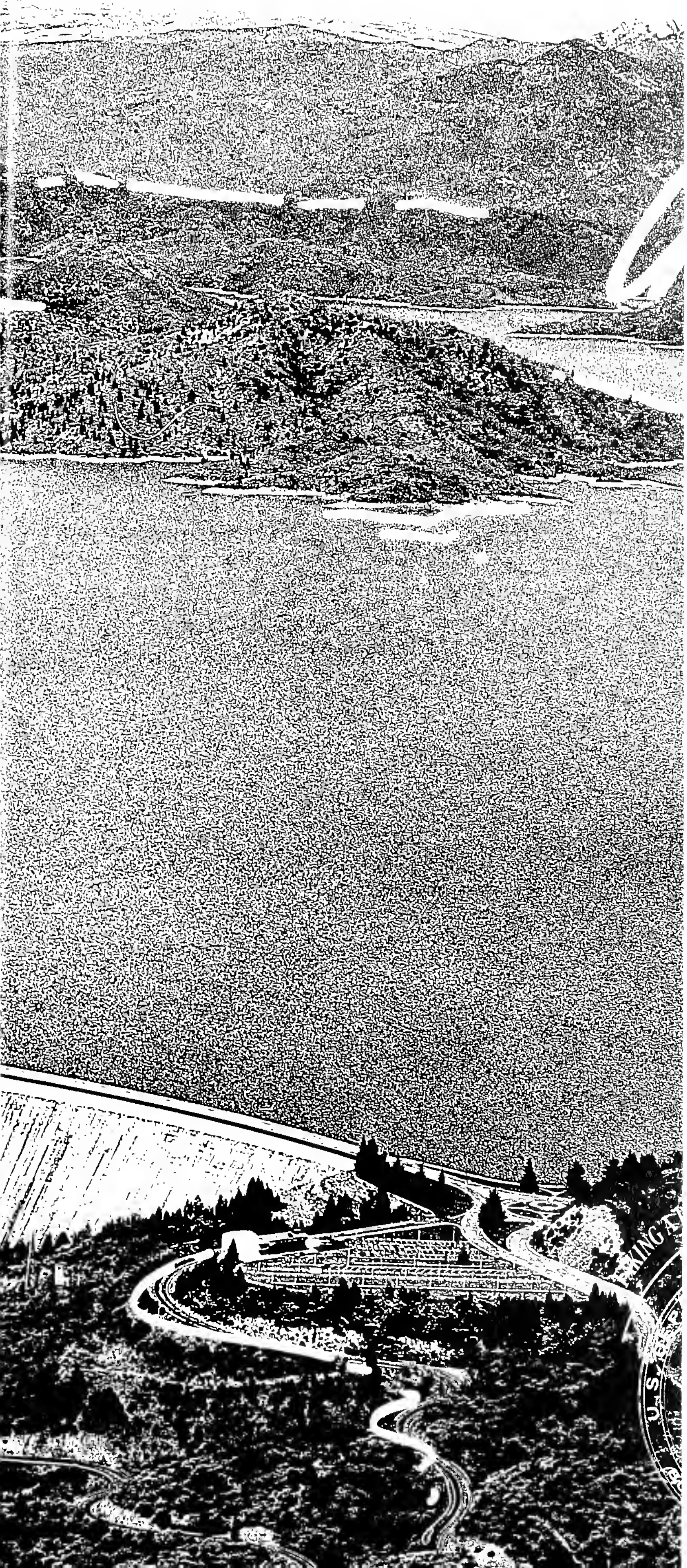
- Diversity of peak loads
- Diversity of forced outages
- Balancing of load-forecasting errors
- Coordinated planning of capacity additions
- Scheduling of maintenance
- Diversity in the time required for maintenance
- Hydrologic diversity of adjacent interconnected hydroelectric systems
- Reduction in total required reserve capacity

Operating economies are increased by centrally dispatching power from the most economical sources in the pool. Diversity in fuel burning is also possible. Greater reliability can be achieved through such coordination.

Interconnecting and coordinating hydropower resources in a river basin provide outstanding opportunities to help preserve the environmental assets of the river basin: water quality can be improved, fisheries can be protected, and riparian habitat and wetlands can be preserved. These are achieved best by river basin management rather than by approaching the issues plant by plant.



Shasta Dam on the Sacramento River near Redding, California, serves to control flood water and store surplus winter runoff for irrigation use in the Sacramento and San Joaquin Valleys. The dam also provides maintenance of navigation flows and conservation of fish in the Sacramento River. Shasta Powerplant, located just below Shasta Dam, has five main generating units and two station service units with a total capacity of 539 MW.

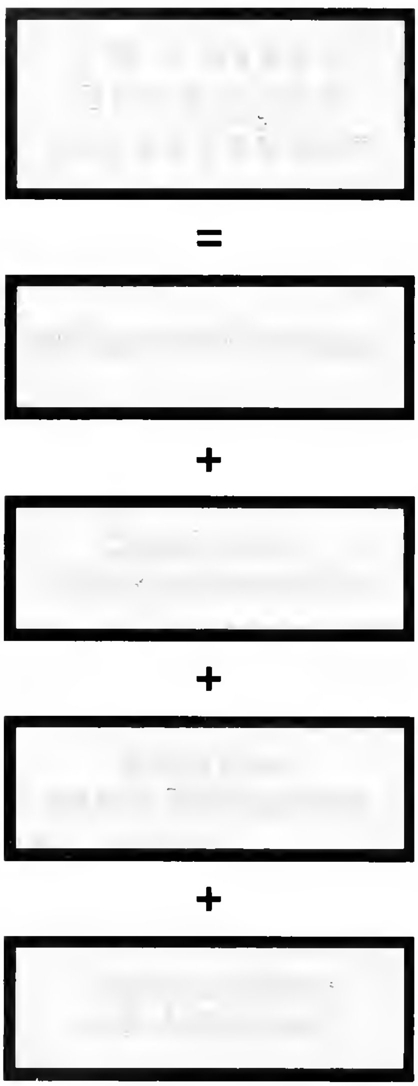


Chapter Two

Reclamation's Strategies to Meet National Energy Needs

Reclamation is the Nation's second largest producer of hydroelectric power, operating 52 powerplants with an installed capacity of 13,800 MW. Reclamation powerplants annually generate about 60 billion kWh of hydroelectric energy. The production of an equivalent amount of energy from thermal powerplants would require about 115 million barrels of oil. Reclamation's hydropower assets provide many opportunities to increase generating capacity and energy production.

Reclamation's Energy Equation



Reclamation has identified six principal strategies to help meet the Nation's energy and related economic and environmental needs:

1. Improving efficiency by enhancing mechanical, structural, and operational efficiencies at Reclamation facilities.
2. Increasing water and energy conservation.
3. Developing additional generating capacity by increasing capacity at existing facilities, uprating, exploring new construction possibilities and options including pumped-storage development and integration with other energy sources, and enhancing potential through precipitation management.
4. Pursuing research and development opportunities to solve national and international water and power resources problems and to increase efficiency, conservation, safety, productivity, and resource use. Also promoting an active technology transfer program that supports cooperative research agreements to grant and accept funds, services, and property among collaborating parties.
5. Enhancing existing and pursuing innovative financing and cost recovery activities.
6. Identifying opportunities to enhance environmental compatibility.

A balance between supply and demand can be achieved by reducing demand as well as increasing supply. The same technical skills are required regardless of which side of the supply/demand equation one endeavors to work on. The strategies discussed here deal with both sides of a balanced supply and demand equation.

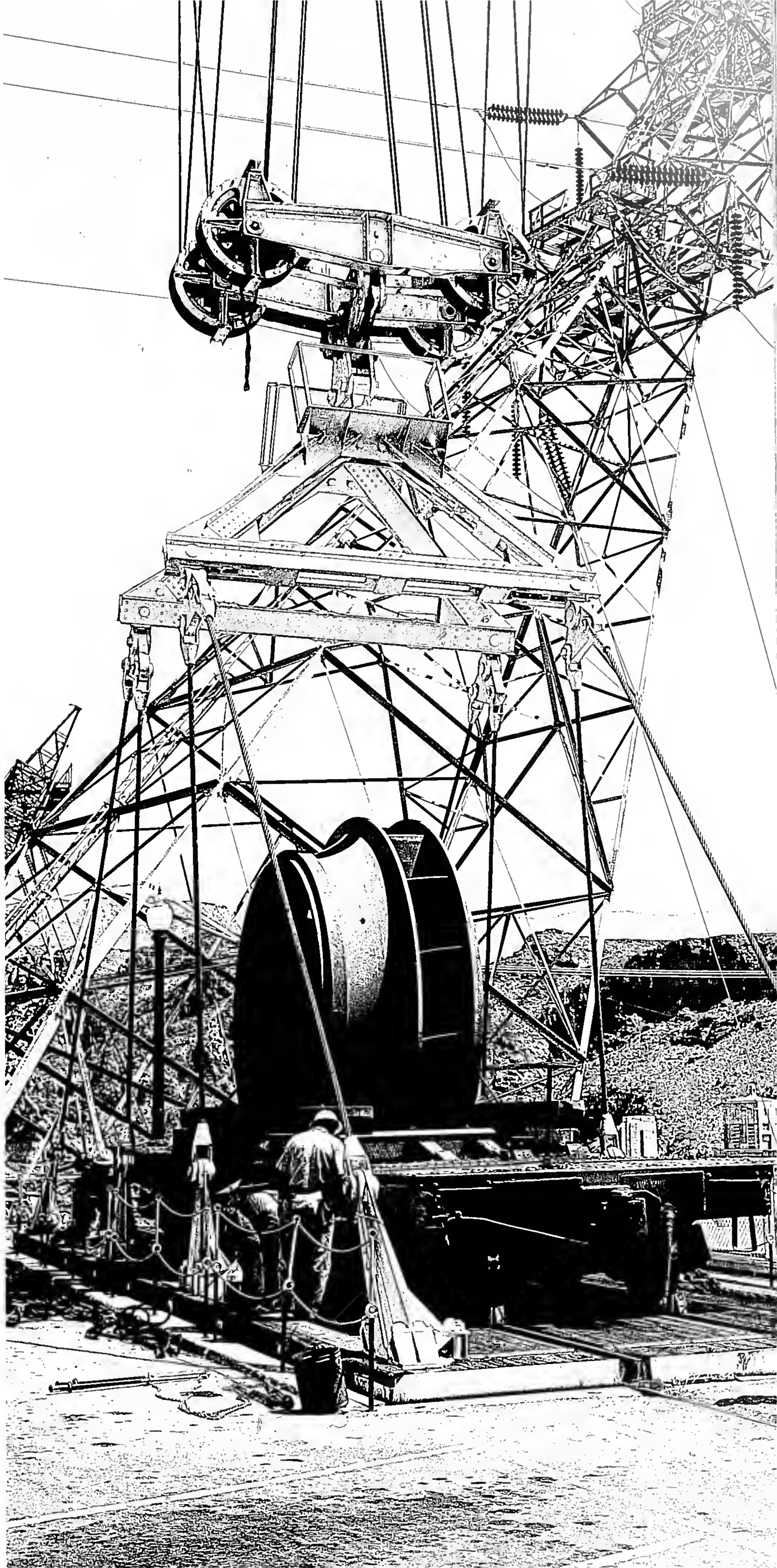
Efficiency and Operational Improvements

Increasing costs of generating electric power and the high financing costs for new installations have motivated power producers to modernize existing plants. This is especially true for hydroelectric plants, where the incremental costs of added generation through improved efficiencies are usually quite low compared to new construction costs. These efficiencies can be divided into two general areas: mechanical and structural, and operational.

Mechanical and Structural Efficiencies

The average energy generated annually by Reclamation hydroelectric plants is about 60 billion kWh. **Thus, each percentage increment in improved efficiency and plant availability could increase annual generation by about**

Installation of a turbine runner at the Hoover Powerplant. Hoover Powerplant has 19 generating units which were placed in operation between 1936 and 1961. The units range in size from 2.4-MW station service units to 130-MW main units for a total capacity of 1,930 MW.



600 million kWh. At the average United States retail value of electricity (75 mills/kWh), each percentage increment in improved efficiency would be worth the equivalent of $45 million. Because hydropower generation is controlled by water supply, increase in unit availability does not necessarily result in increased generation or efficiency unless excess water is available. However, increases in operating efficiency of the equipment do result in direct gains.

Many hydroelectric facilities are near the end of their service lives and are in need of major renovation or replacement. Many facilities were constructed in an era when it was not economically feasible to develop the full potential of a specific site. To obtain the full advantage of the power resource, *existing powerplants can be modified,* where economically justified and environmentally compatible.

Potential modifications for increasing efficiencies include:

- Replacing old turbine runners with an improved design to eliminate losses caused by cavitation or other imperfections.
- Fine-tuning turbines to obtain maximum efficiency. This may require testing (including flow measurement) to determine when the unit is operating at maximum efficiency.
- Reducing system water leakage.

New, higher-rated transformer being installed as part of Reclamation's uprating program. This program, initiated in 1978, will eventually result in an increase of around 2,000-MW generating capacity from existing Reclamation generators. The uprating program involves about 30 percent of Reclamation's 190 generating units.

Increasing hydraulic head and reservoir storage, where appropriate, by using flashboards.

Installing trashrack rakes or equipment to reduce head losses caused by debris buildup.

Installing new electronic governors and monitoring equipment to operate equipment at peak efficiency.

Replacing outdated rotating excitation systems with new electronic systems to reduce losses.

Applying low-friction coatings to waterways to reduce losses.

Replacing old transformers with new, higher efficiency transformers.

Hydropower facility efficiencies often are constrained by nonpower objectives. These include water releases to provide for flood control, water storage, water delivery, water conservation, water quality improvements, environmental protection, and mitigation of environmental damages. However, operating efficiencies can still result in additional power and better use of the hydropower resource. These opportunities could be realized by improvements in water release scheduling, power scheduling, and power system controls. Reclamation will continue to investigate opportunities for:

Collecting more accurate power operations data and hydrologic information.

Improving existing computer models to predict more accurate schedules and operations.

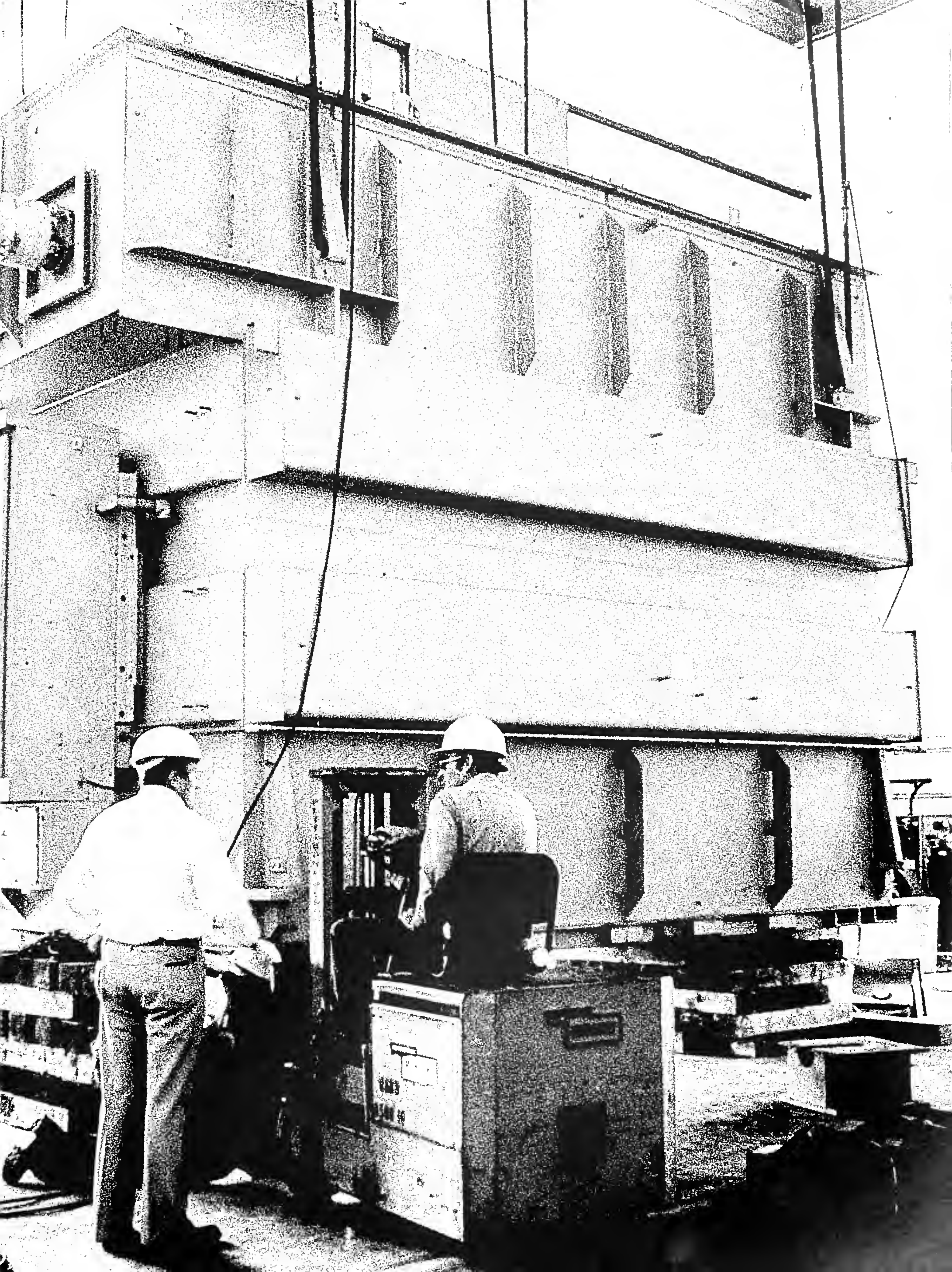
Developing computer systems for optimizing power generation in each plant, series or system of plants, and basinwide.

Improving generation timing by controlled water releases to match power system loads where appropriate, and to coordinate with thermal generation and environmental needs.

Optimizing unit loading by using highest-efficiency units at the most efficient point.

Improving remote and supervisory control systems to provide for better staffing, automated data logging, and performance of routine tasks and/or remote control of powerplants.

Continuing an effective preventive maintenance program, including the use of maintenance management systems (on-line diagnostics systems) and reliability centered maintenance to minimize equipment downtime and maximize service life.



One of the most challenging issues facing hydropower development today is achieving balance among competing objectives and priorities.

Conservation

The energy crisis of the 1970's raised public awareness about the importance of using both energy and water more efficiently. Energy and water conservation are closely tied; less water used means that less water has to be pumped, resulting in lower energy needs. Withdrawing less water from a reservoir increases the operating head or efficiency of a powerplant. Modifications to water scheduling and operation can reduce peak demands, thereby reducing peak capacity needs for both water and energy.

Conservation improvements can result in less internal energy use and greater net power output for marketing. Examples of conservation actions include:

- Converting from high- to low-pressure sprinkler systems
- Retrofitting pumps with more efficient units or components
- Improving on-farm irrigation management
- Rescheduling irrigation pumping, when possible, to off-peak periods
- Installing canal linings
- Controlling aquatic weeds
- Using waste energy sources for plant heating and cooling
- Improving lighting efficiency
- Upgrading building insulation
- Reducing station power usage
- Improving pumping efficiency for irrigation water delivery
- Providing conservation education to municipal and irrigation users

In the hydropower-rich Northwest (about 70 percent of total regional load is served by hydropower), the Bonneville Power Administration (BPA) was mandated by the Pacific Northwest Electric Power Planning and Conservation Act of 1980 to consider conservation as a priority source of new energy for the region. During the last 10 years, end-user energy conservation programs in the commercial, industrial, residential, and agricultural sectors have added an average of 300 MW to BPA's energy supply within the Pacific Northwest Region. This represents enough energy to serve a city of 100,000. These programs are low-cost — about 2 cents per kWh or half the cost of energy from a coal-fired plant.

During this 10-year period, BPA invested $10 million to improve energy efficiency in irrigated agriculture. With technical assistance from Reclamation, BPA has helped farmers convert from high-pressure to low-pressure sprinkler systems, retrofit pumps and mainlines, and improve on-farm irrigation management and

Nevada wing of Hoover Dam Powerplant, on the Colorado River in Boulder Canyon. The powerplant is located at the toe of the dam and extends downstream 650 feet along each canyon wall. There are 17 main generating units and two station service units which produced 4.3 billion MWh of energy in fiscal year 1990.

scheduling technology. These efforts resulted in an estimated 3 MW savings at a cost of less than 1 cent per kWh for hardware replacements and an undetermined amount of additional savings potential through an irrigation water management education program.

Potential energy savings in agriculture are small compared to those possible in commercial, industrial, and residential programs (irrigated agriculture consumes less than 5 percent of total regional load), but they are low cost, very dependable, and can contribute additional generation potential by conserving water within the hydropower system. Energy used for irrigation pumping accounts for about 7 percent of the total energy generated by Reclamation hydroelectric powerplants.

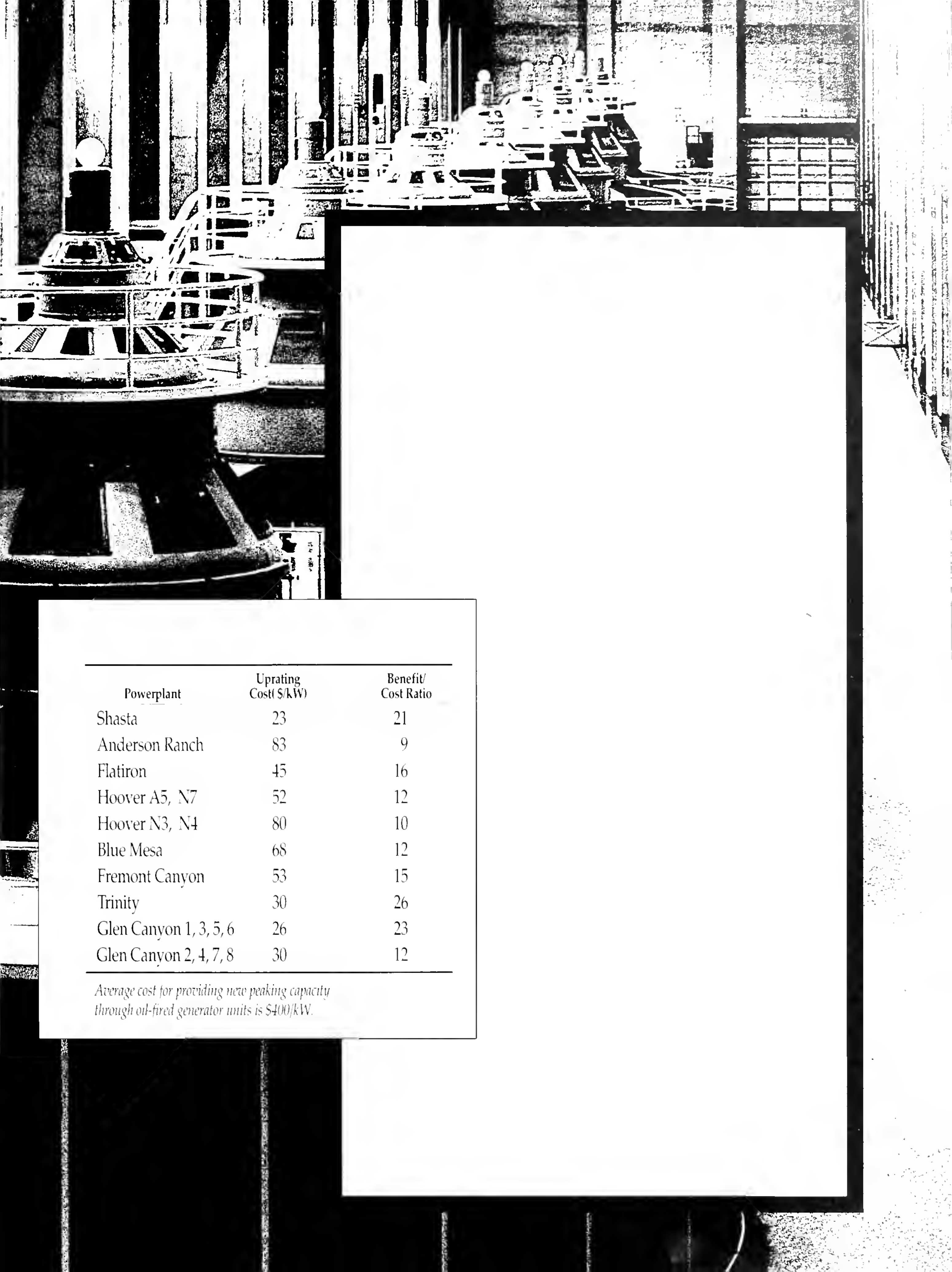
Additional Generating Resources

As of January 1, 1988, the Federal Energy Regulatory Commission (FERC) estimated the total potential for additional conventional hydropower capacity development in the United States at 74,700 MW. Of this amount, 50,400 MW (67 percent) is located in the 17 Western States served by Reclamation. Much of this capacity is precluded from development by economic, environmental, or other factors. A list of the most viable new sites is shown in Table 2.1.

Additions to Existing Facilities

The addition and/or enlargement of powerplants at existing Reclamation facilities is generally an attractive means to develop additional energy resources. Although most proposals appear technically feasible, economic and environmental factors have prevented many from being implemented. The Western Energy Expansion Study, conducted by Reclamation in 1976-77, investigated potential additions to Reclamation facilities. Thirty-one proposals for additions were considered, with a potential capacity increase of 2,180 MW. Although the Congress did not authorize any of these sites for Federal development, a capacity of 368 MW was eventually added through the FERC licensing program.

Other opportunities for hydropower development at existing facilities undoubtedly exist. Those not constrained by environmental factors may be potential candidates, given the right economic conditions.

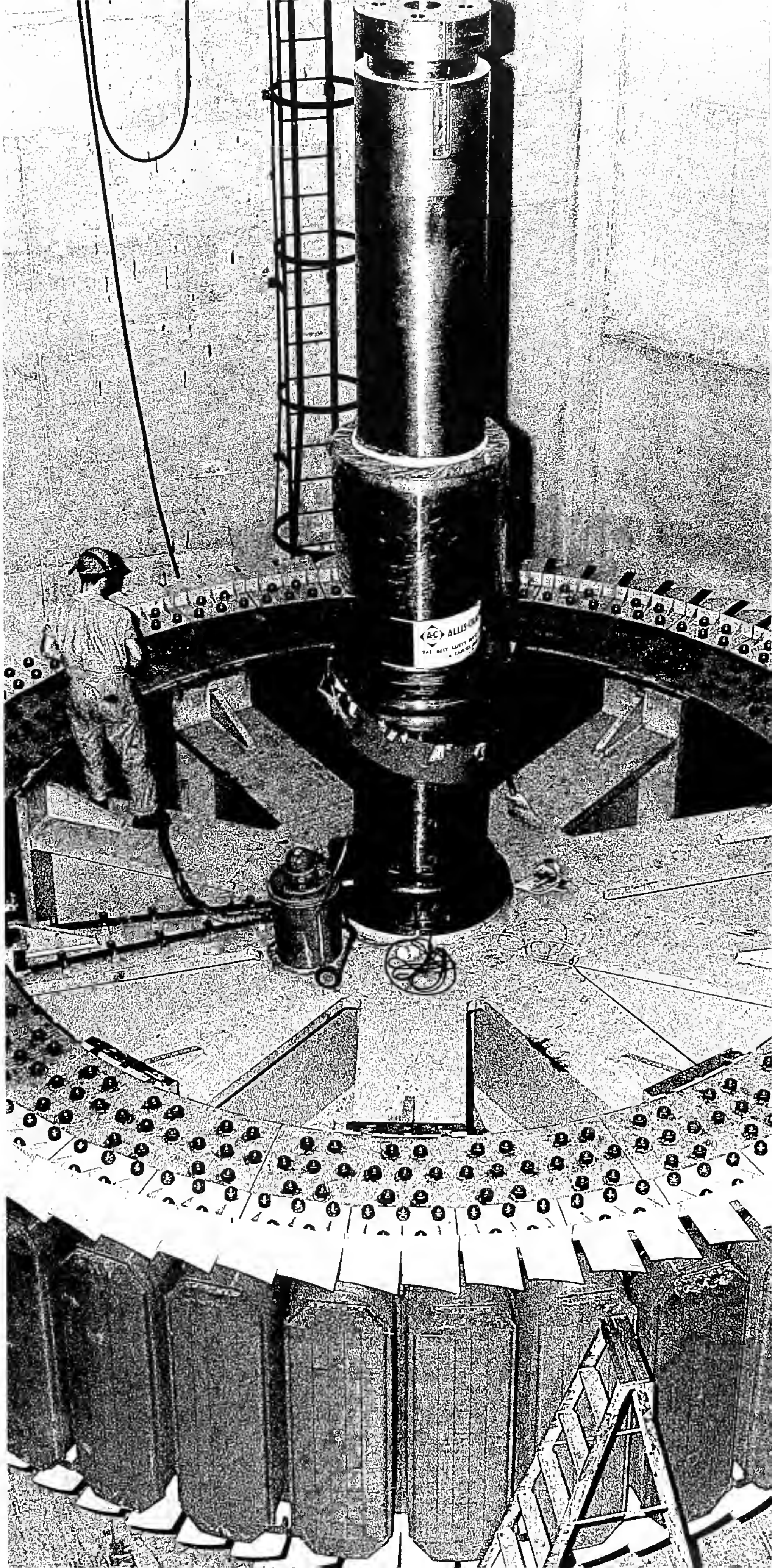


Powerplant	Uprating Cost($/kW)	Benefit/ Cost Ratio
Shasta	23	21
Anderson Ranch	83	9
Flatiron	45	16
Hoover A5, N7	52	12
Hoover N3, N4	80	10
Blue Mesa	68	12
Fremont Canyon	53	15
Trinity	30	26
Glen Canyon 1, 3, 5, 6	26	23
Glen Canyon 2, 4, 7, 8	30	12

Average cost for providing new peaking capacity through oil-fired generator units is $400/kW.

Region	Project[1]	Powerplant Name	Type[2]	State	Estimated Additional Capacity (MW)[3]	Status[4]
PN	Minidoka	**Minidoka**	A	ID	20	UC
MP	CVP-Shasta Division	**Keswick (Enlargement)**	A	CA	10[6]	P
MP	CVP-Shasta Division	**Shasta (Enlargement)**	A	CA	NYD[5]	P
LC	Boulder Canyon	**Hoover**	A	AZ-NV	500	UI
					Subtotal: 530	
GP	Shoshone	**Buffalo Bill**	N	WY	18	UC
MP	CVP-Auburn-Folsom South Unit	**Auburn**	N	CA	300	A
UC	CUP-Bonneville Unit	**Last Chance**	N	UT	45	A
					Subtotal: 363	
GP	Shoshone	**Shoshone**	A	WY	3	UC
GP	P-SMBP-Eastern Division	**Yellowtail Afterbay**	A/SS	MT	8	P
UC	CUP-Bonneville Unit	**Jordanelle**	N/SS	UT	10	A
UC	CUP-Bonneville Unit	**Monks Hollow**	N/SS	UT	NYD[5]	A
UC	CUP-Bonneville Unit	**Diamond Fork**	N/SS	UT	NYD	A
UC	Dallas Creek	**Ridgway**	N/SS	CO	4	A
UC	Dolores	**McPhee**	N/SS	CO	1	UC
UC	Dolores	**Towaoc Canal**	N/SS	CO	12	UC
					Subtotal: 38	
LC	Spring Canyon	**Spring Canyon**	N	AZ	1500-4000[8]	P
LC	Central Arizona	**New Waddell**	N	AZ	44	UC
					Subtotal: 4044	
					Grand Total: 4975	

A rotor for one of Hoover Dam's hydroelectric generating units. The rotor is the rotating electromagnet of the generator which is directly connected to the turbine.



[1] *Project abbreviations:*

CVP	=	Central Valley Project
CUP	=	Central Utah Project
P-SMBP	=	Pick-Sloan Missouri Basin Program

[2] *Type abbreviations:*

N	=	All new facilities (including dams, waterways, etc.)
A	=	Additions using existing facilities (including dams, waterways, etc.)
SS	=	Small-scale (less than 15 MW)

[3] *Capacity values stated as whole numbers: fractions have been rounded.*

[4] *Status abbreviations:*

UC	=	Under construction
A	=	Authorized for construction
UI	=	Under investigation
P	=	Potential

[5] *Not yet determined (NYD): no value included in subtotal or grand total figures*

[6] *Replacement of existing 5.6 MW Shoshone Unit*

[7] *Seeking non-Federal sponsors*

[8] *Project being proposed as a joint Federal/non-Federal participation study. This study is currently inactive.*

[9] *Enlargement is pending on a non-Federal pumped-storage project using Keswick Reservoir.*

Hungry Horse Dam and Powerplant on the South Fork of the Flathead River in Montana. This 4-unit powerplant is being uprated from 285 MW to 428 MW. The principal power benefit from this project results from its ability to store water through the spring flood season for later release when needed. The stored water eventually passes through a series of 19 downstream powerplants.

Table 2.2 lists potential hydropower additions at existing Reclamation dams. This list is not all inclusive, and it should not be assumed that sites are environmentally or economically acceptable.

Table 2.2: Additions Undeveloped Hydropower Potential at Existing Reclamation Dams

Project	Dam	State
Boise	Anderson Ranch	Idaho
Boise	Black Canyon	Idaho[1]
Boise	Boise River Diversion	Idaho
Rio Grande	Caballo	New Mexico[1]
Weber Basin	Causey Dam	Utah
Emery County	Joes Valley	Utah
Paonia	Paonia	Colorado
Central Utah	Steinaker	Utah
Palo Verde Diversion	Palo Verde	Arizona
Fryingpan-Arkansas	Pueblo Dam	Colorado[1]
Uncompahgre Valley	Taylor Park	Colorado
Central Valley	Lewiston	California
Hungry Horse	Hungry Horse Enlargement	Montana[2]
Palisades	Palisades Enlargement	Idaho[1]
Yakima	Tieton	Washington[1,2]
Deschutes	Wickiup	Oregon[1,2]
Pick-Sloan Missouri Basin	Tiber	Montana[2]
Pick-Sloan Missouri Basin	Canyon Ferry Addition	Montana[2]
Colorado-Big Thompson	Green Mountain Afterbay	Colorado[2]

[1] These facilities were recommended in the *1980 Report on Assessment of Hydroelectric Development at Existing Facilities* for further study.

[2] These facilities were recommended in the *1977 Western Energy Expansion Study (WEES) Report* as candidates for further study.

Reclamation will look at a variety of energy storage options to help reduce the environmental degradation of peaking power operations in river basins. Mt. Elbert Pumped-Storage Powerplant is on the north shore of picturesque Twin Lakes, Colorado.

Low-Head Small-Scale Developments

Thousands of sites exist where small plants can be built on low-head structures, canals, and existing facilities. While large potential exists for low-head hydropower, many technological, environmental, economic, and institutional problems remain.

Pumped-Storage Developments

Pumped storage is a method to store water in reserve for peak period power demands. Water is pumped to a storage pool above the powerplant when customer demand for energy is low, such as at night. Water is then allowed to flow back through the turbine when demand is high. The reservoir is like a battery; it stores water power when demand is low and produces maximum power during daily and seasonal peak periods. An advantage of pumped storage is that generating units are able to start up quickly and make rapid adjustments in energy demand. These systems operate efficiently when used in conjunction with base-loaded thermal units.

A large potential exists for pumped-storage development which functions exclusively for peak-power generation. Although pumping water to a reservoir consumes more power than that generated by water releases of the same amount, pumped storage may offset the need for additional and more expensive on-peak coal-or gas-fired generation. Therefore, pumped-storage development must be considered as a viable resource and a "clean" alternative to peaking options like combustion turbines.

For a pumped-storage project to offset high-cost peaking generation, a supply of low-cost off-peak pumping energy must be available. Therefore, if coal and nuclear powerplants are not constructed, large amounts of pumped storage are unlikely to be developed.

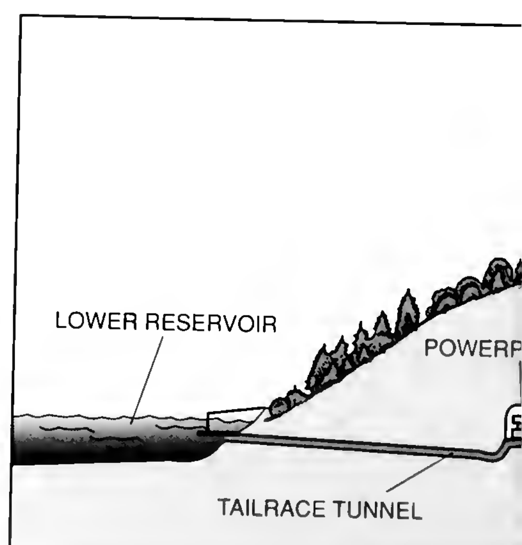
Other Energy Storage Systems

Many of the adverse environmental effects of hydropower result from large fluctuations of instream flows below hydropower plants. If effective storage devices can be devised, hydropower releases could be modified to lessen adverse impacts on instream flow needs. The energy produced during off-peak periods would be stored for release during periods of peak demand. Because Reclamation plants are composed almost entirely of hydro-based generation, Reclamation could assume a lead role in constructing other energy storage systems to meet peak demand requirements with fewer environmental impacts.

The Electric Power Research Institute has produced other proven technologies, including compressed air and battery energy storage systems. It may be cost effective for Reclamation to construct compressed air energy storage plants (CAES) at selected major hubs of the Federal transmission grid. Research results on superconducting magnetic energy storage systems may also make this technology cost-effective in the future.

Another energy source, hydrogen, can contribute to both a cleaner environment and provide greatly needed storage capacity, much like hydropower. Hydrogen can be produced from any fuel. It can be transported and stored in many forms and is available today. It is clean and is an ideal fuel for power generation.

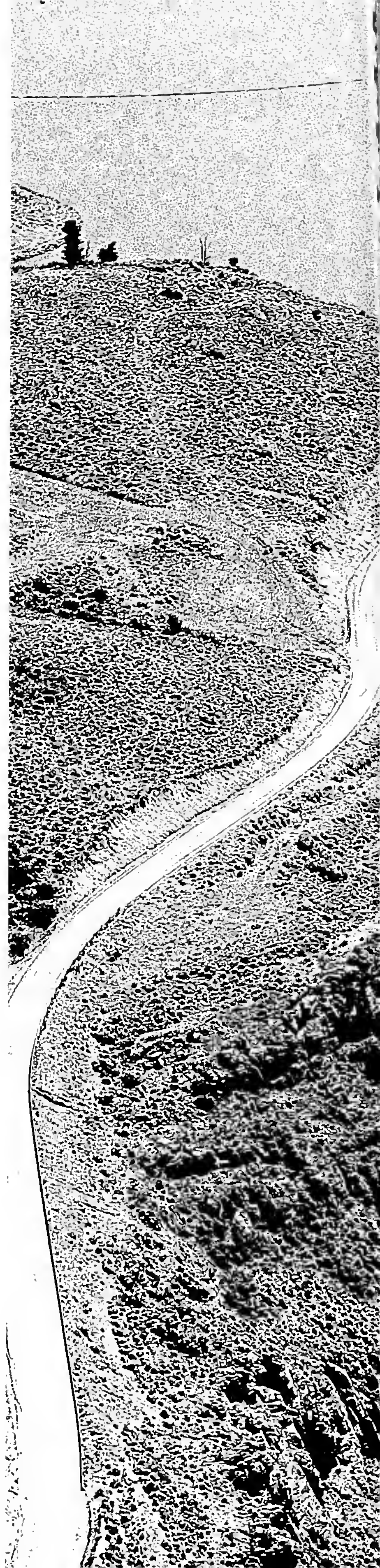
Exploring and improving upon these and other types of energy storage technologies can vastly enhance the environment and energy systems economics.



Schematic of pumped-storage system. Water is stored in reserve for peak power demands, offsetting the need for more expensive oil-or gas-fired generation.

PER RESERVOIR
PENSTOCK
TUNNEL
TURBINE

Blue Mesa Dam and Powerplant are located on the Gunnison River about 30 miles below Gunnison, Colorado. The zoned earthfill embankment dam has a height of 390 feet. The two generators at this plant produced almost 150,000 MWh of energy in 1990.



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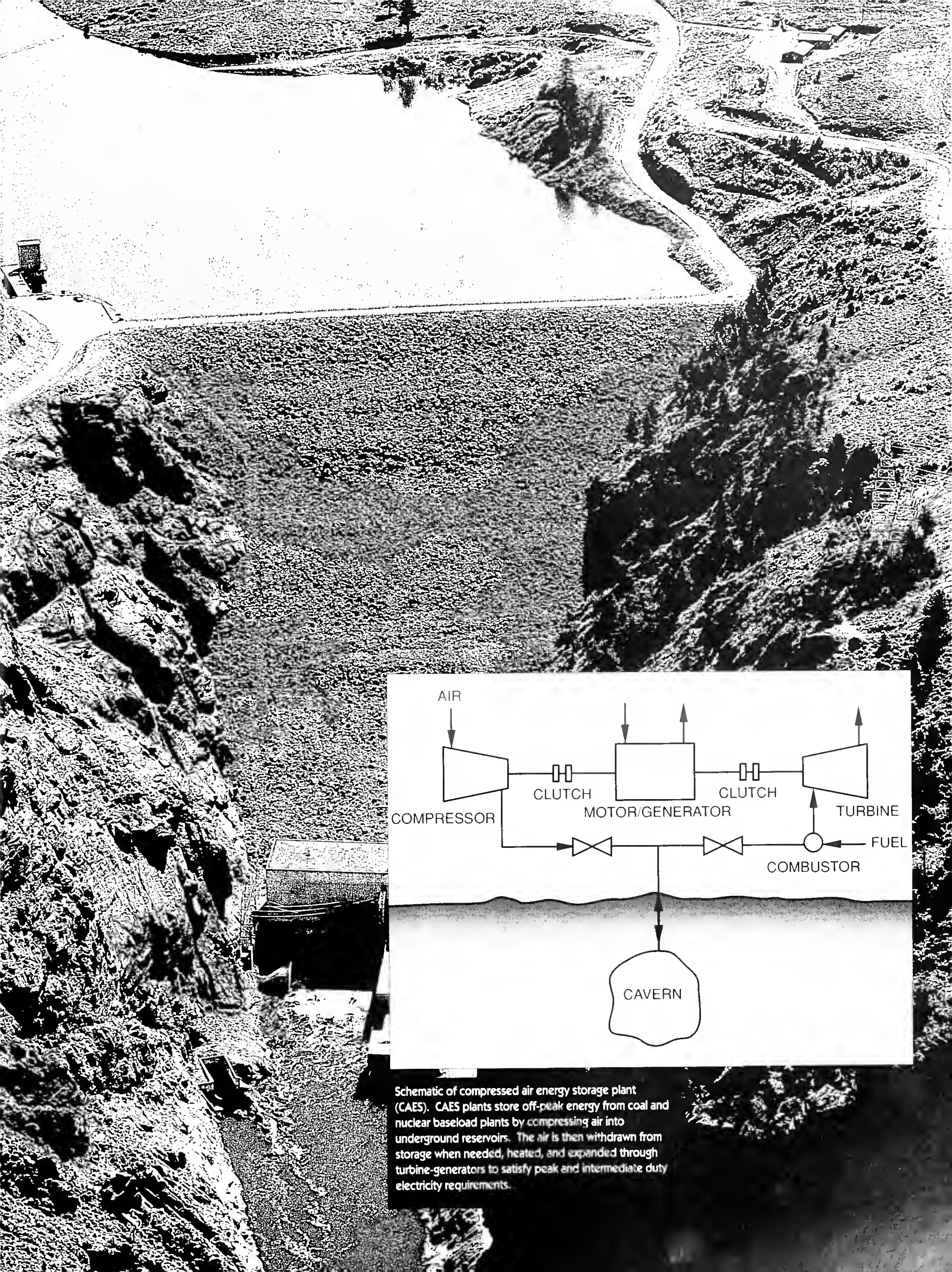
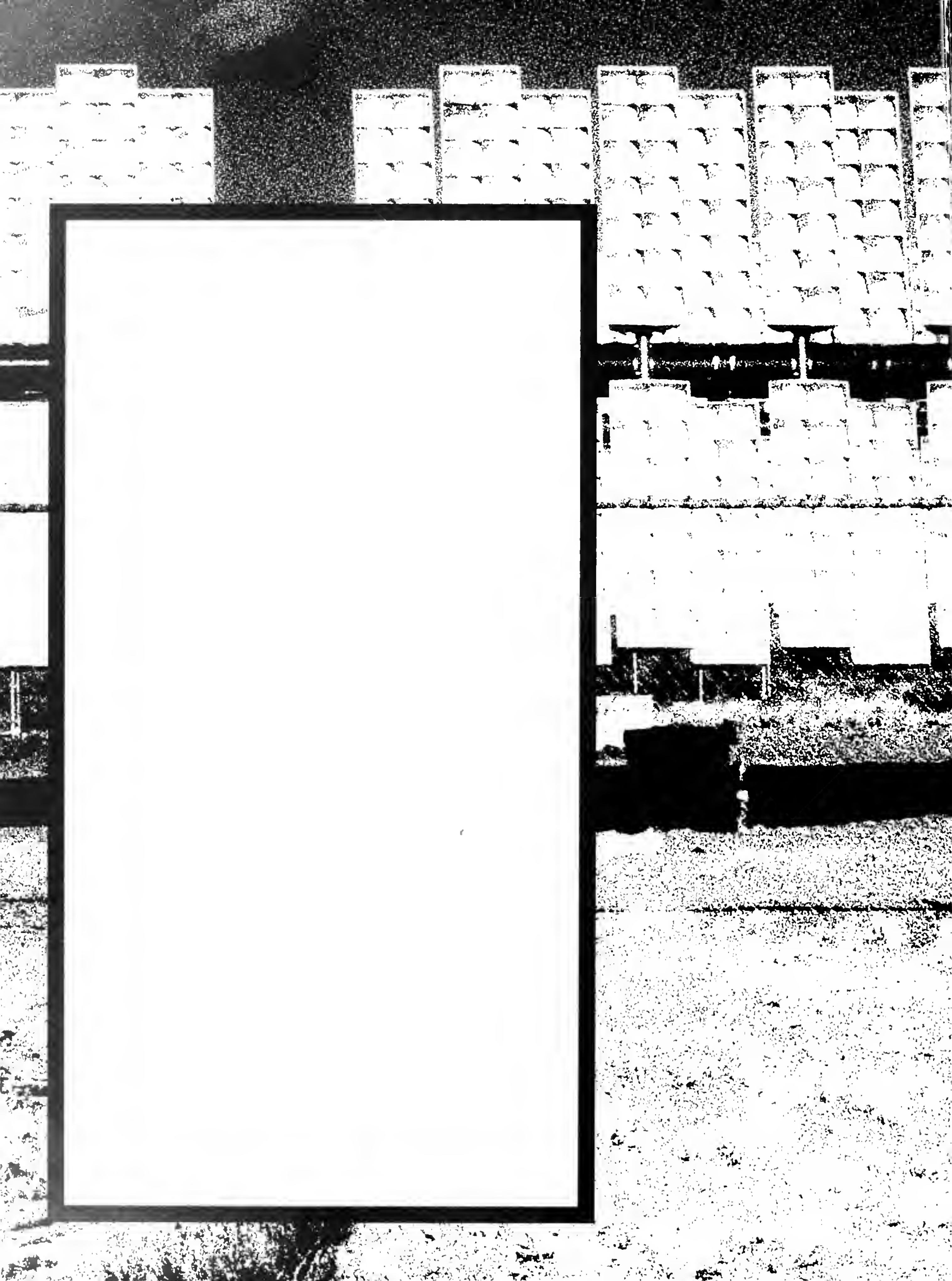
Integrating renewable resources, such as wind and solar power, with the Federal hydroelectric system could prove beneficial for electric power generation. The most promising of these are medium-sized wind-turbine generators, solar thermal powerplants, solar ponds, and photovoltaics — all of which Reclamation has experience in constructing and operating.

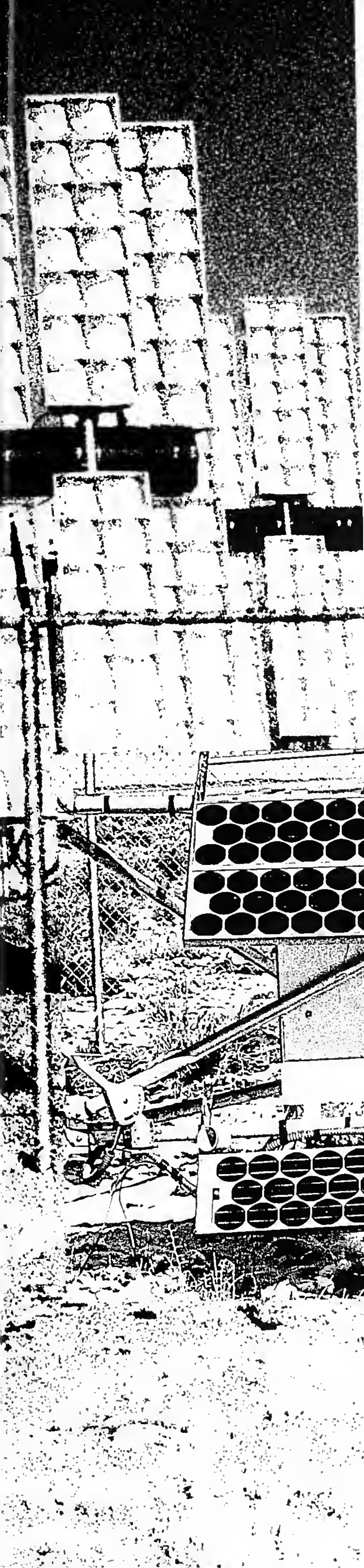
Possible techniques that could be used for integrating large grid-connected renewable energy projects consist of providing a discrete amount of firm capacity and energy daily for integration purposes. On days of good solar insolation or wind velocities, the solar or wind powerplant generation could reduce the ramping of hydroelectric generators needed to meet peak demands, as well as reduce part of the peak generation itself. In cases in which hydroelectric generation is the dominant energy source, the uses of solar and wind powerplant generation could offset hydroelectric generation. The saved hydroelectric energy could then be stored in reservoirs as unreleased water and could be released when little or no solar/wind energy is available to meet the daily firm energy obligations in cases where power is the predominant water release.

One operational constraint that limits integration is that project water usually is not released for power production alone; rather, it is released for a combination of downstream priority uses, including flood control, agriculture, recreation, municipal and industrial requirements, and instream flows. Power generation at Reclamation hydroelectric powerplants is frequently subordinate to the demands of water users downstream. These limitations must be considered at each location when integrated with other energy technologies; however, in general, hydroelectric resources with storage reservoirs greatly enhance the ability to exploit other renewable energy sources. Power systems with little or no storage capacity are unable to economically regulate power generation, as required by system demand. This ability is an important cost-saving characteristic of an integrated power system.



Schematic of compressed air energy storage plant (CAES). CAES plants store off-peak energy from coal and nuclear baseload plants by compressing air into underground reservoirs. The air is then withdrawn from storage when needed, heated, and expanded through turbine-generators to satisfy peak and intermediate duty electricity requirements.

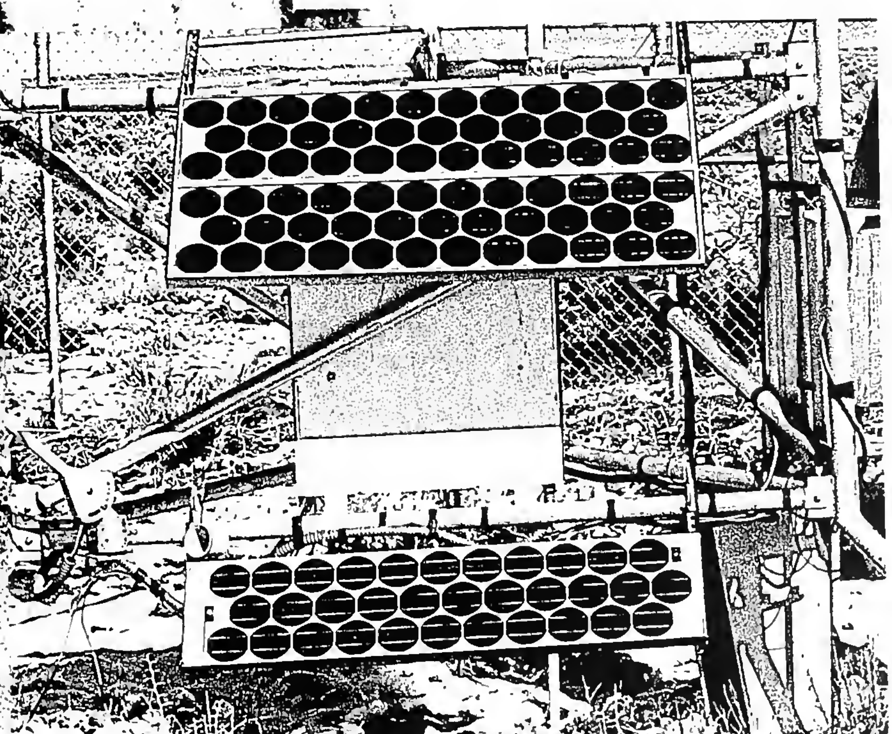




Concentrator photovoltaic array for the Closed Basin Groundwater Pumping Plant, Colorado. The arrays automatically follow the sun, gathering solar energy to pump water wells. The closed Basin Project includes over 100 underground wells.

Additional Generation Through Increased Water Yield

Precipitation and vegetation management, carried out individually or as coordinated activities as part of a long-range water resources management program, offers the potential for increasing watershed yield. Hydropower generation would be a significant beneficiary of increased water yield because more water would be available for generation. In addition, higher reservoir levels increase the powerplant operating head.



A photovoltaic-powered remote weather station is used to measure precipitation and other weather data in support of Reclamation's weather modification program.

Reclamation has been a national and international leader in advancing precipitation and vegetation management research and technology development. Enhanced snowpack through precipitation management is estimated to increase long-term annual yields by as much as 10 to 15 percent. Similarly, vegetation management offers the potential for increasing long-term annual water yields by as much as 10 percent.

With the necessary reservoir powerplant infrastructure already in place, precipitation and vegetation management would be significant, nonstructural, long-term means for improving water and power development and management.

Only by building a strong foundation of scientific understanding and cooperation among all interests can we hope to create effective strategies to protect the environment. Reclamation is committed to expanding our understanding of the environment and hydropower generation as it affects the world around us.

Reclamation's research programs, though aimed primarily at satisfying mission-related objectives, also make major contributions to solving national and international power and water resources problems. Reclamation conducts scientific and engineering investigations in six major areas related to hydropower:

Research in water quality; wetlands and riverine habitat; aquatic ecology; and fish protection and management.

Research in improving the environmental compatibility of hydropower operations with instream flows, water quality, fish and wildlife, recreation, and river bank erosion.

Structural and nonstructural alternatives—groundwater, surface water, hydraulic control water measurement system improvements, precipitation and vegetation management, conservation, and other alternatives.

Basinwide reservoir operations and management, optimizing the balance of all system values, including power, water supply, flood control, recreation, water quality, and fish and wildlife.

Research in technologies for design and construction of new facilities, and for maintenance, rehabilitation, and modification of existing facilities. Includes research for dam safety.

Development of new operation and maintenance techniques to improve facility efficiency and performance of facilities.

Development of new techniques for testing of material properties and control of construction materials.

Design of power apparatus, controls, automation systems, and other devices to enhance operation and maintenance of powerplants and other power facilities, resulting in reduced costs and improved system reliability, stability, and safety.

Renewable energy technologies and new energy storage systems applied to Reclamation projects.

System stability-related research to ensure and enhance power system security and stability and full use of generating capability, and to maximize system efficiencies.

New and improved methods of analysis, testing, and maintenance to increase reliability, extend equipment life, and reduce associated operation and maintenance costs.

Cooperation with EPRI and utilities in research on the effects of exposure to electric and magnetic fields, real-time power system control, higher capacity transmission options, and high capacity power electronics.

Support of programs to better understand potential effects of global climate change on hydropower and to develop strategies responding to possible adverse effects of climate change on water and energy supply and demands.

Water conservation is a necessity in the dry West. Reclamation is working closely with water users and other agencies to improve irrigation techniques and water conservation methods.

Reclamation promotes and supports a technology transfer program, entering into cooperative research agreements to grant and accept funds, services, and property among collaborating parties. The Technology Transfer Act of 1986 enabled Reclamation to further develop and explore technology transfer activities.

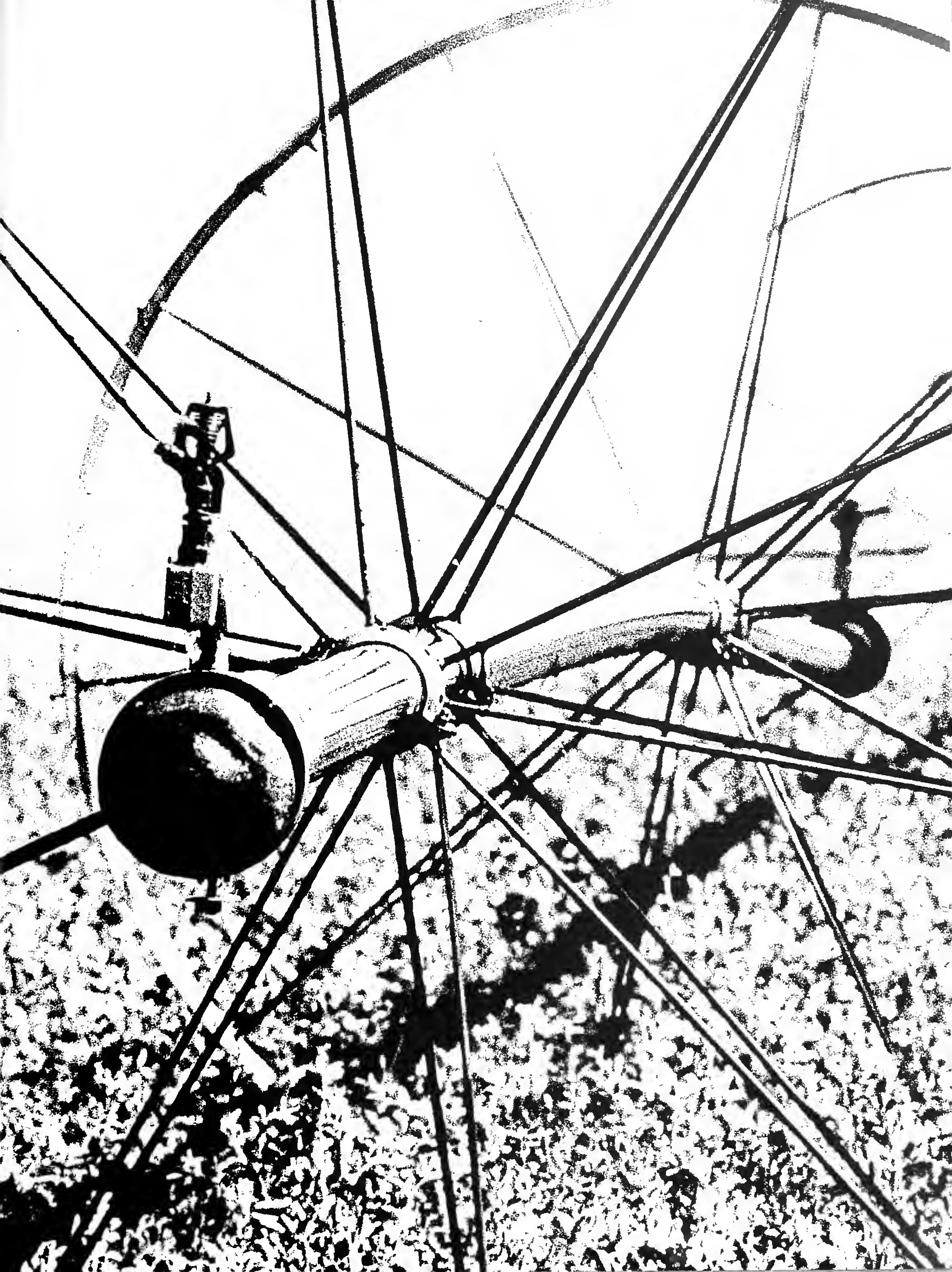
Project planning, design, and construction
Hydrology
Hydraulics
Environment
Economics and financing
Operation and maintenance
Research

Publishing reports on active projects.
Actively participating in hydropower workshops and conferences.
Participating in training and education programs.
Responding to inquiries and issuing information upon request.
Publishing engineering manuals and reports on current and potential technologies.
Participating in joint research and development ventures.
Providing cooperative international hydropower research and development assistance.

Financing and cost recovery activities are integral parts of Reclamation's program responsibilities.

Since the inception of the Reclamation program in 1902, more than $16 billion has been invested in water resource and hydropower facilities. Hoover, Grand Coulee, Shasta, and Glen Canyon Dams — some of the largest hydroelectric powerplants in the world — are among the 52 powerplants built and operated by Reclamation with Federal funding and in cooperation with water and power users.

The operational and physical integrity of the multi-billion dollar investment in Reclamation power projects must be protected and maintained. Under Reclamation law, much of the capital investment in project facilities must be repaid by project beneficiaries, thus requiring diligence in carrying out cost recovery responsibilities.

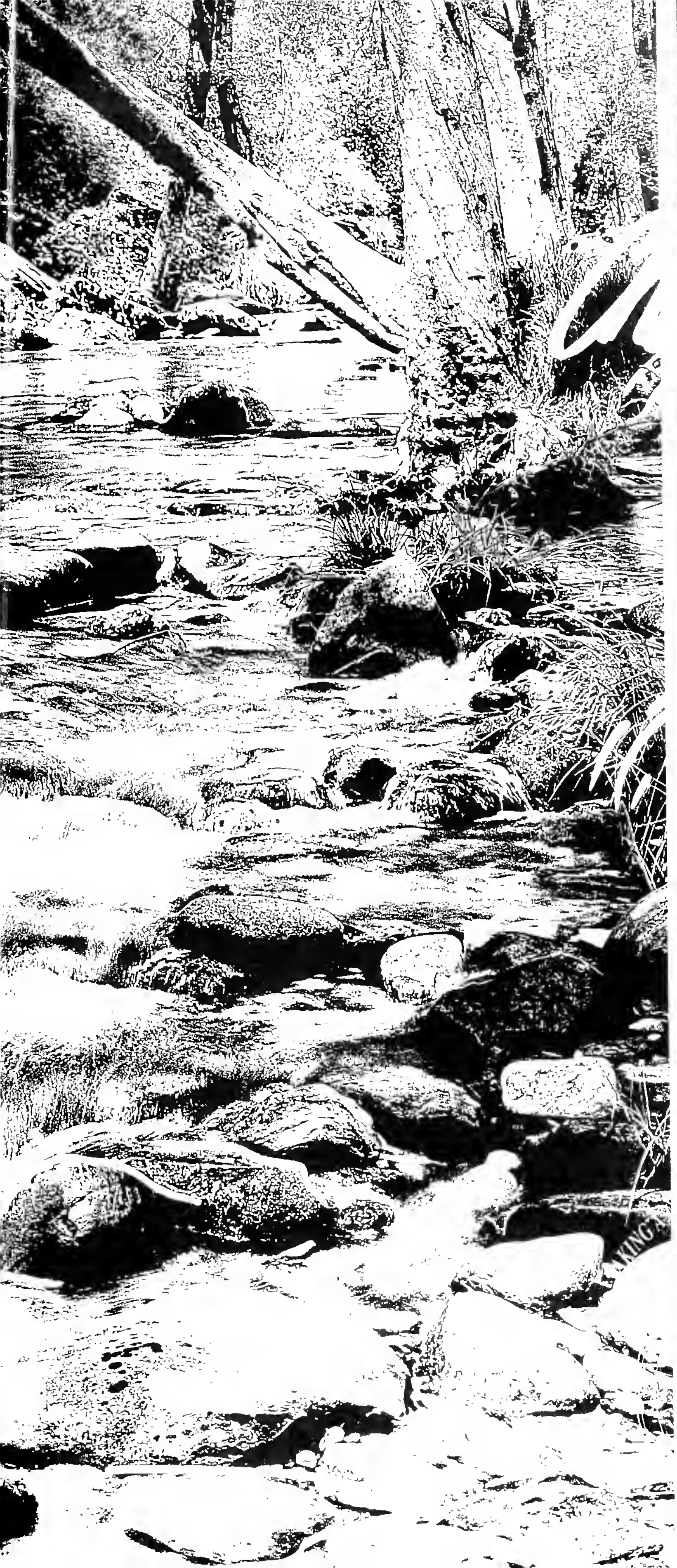


Reclamation projects can be operated more effectively to preserve and enhance environmental resources while still meeting water, power supply, and wildlife needs. (Great blue heron rookery.)

Reclamation will strengthen its existing programs and develop new financing and cost recovery initiatives to:

- Obtain appropriate non-Federal financial participation in all phases of Reclamation's power program, including planning, uprating, development, operation and maintenance, system improvements, research, and conservation.
- Consult and coordinate with the Power Marketing Administrations (PMA's) regarding the financial and budget information needed to meet mutual planning and program responsibilities. This effort will include continuous evaluation of the repayment status of Reclamation's investment and review of the rate structure necessary to provide funds for conducting Reclamation's program. These reviews will ensure sufficient revenues are returned to the Federal Treasury to repay the capital investment, repay operation and maintenance expenses, and provide for future replacements.
- Conduct evaluations of the current economic conditions of major operation and maintenance activities to ensure that budget requests are fully justified. Two areas specifically identified for these justification procedures are equipment replacements and uprates.
- Ensure that the overall operation and maintenance and planning programs are conducted in a businesslike manner. The operation and maintenance program will be closely monitored to ensure that it operates in a preventive maintenance mode and that system reliability is assured.
- Pursue leases for using Reclamation facilities for power production where appropriate.
- Investigate other revenue-enhancing opportunities.
- Accounting practices and other cost recovery policies will be reviewed to identify further opportunities to expedite repayment of the capital investment to the Federal Treasury.

Environmental protection plays a key role in all of Reclamation's decisions.



Chapter Three

Environmental Strategies

In pursuing a National Energy Strategy, society faces the challenge of balancing environmental preservation with its basic energy needs. Conflicts between competing objectives, priorities, and values will necessitate finding the appropriate balance between energy use and efficiency, development of additional energy sources, and environmental preservation. Reclamation's key task in operating its hydropower program is ensuring that all competing water uses are given appropriate consideration.

Reclamation manages 1.7 million acres of water surface in the Western United States. Besides supplying hydropower, these waters are crucial for waterfowl. Reclamation is participating in the North American Waterfowl Management Plan to help rebuild populations of ducks, geese, and other wildlife.

Reclamation is committed to protecting and enhancing habitat and water for wildlife. New hydroelectric development and modifications to existing facilities will be accompanied by environmental analyses to identify and minimize impacts on fish and wildlife.

Environmental strategies associated with hydropower development include considerations such as fish and wildlife, water quality, riverbank stabilization, and riparian habitat. Powerplant operations will be managed to avoid undue impacts to these resources, while providing for sustained economic growth and quality of life amenities such as outdoor recreation.

Fish and Wildlife

The wise stewardship of natural resources entails conservation and enhancement of fish and wildlife resources in conjunction with the development and management of water, power, and land resources.

The loss or modification of habitat; fish entrainment, passage, and reproduction; the effects of system operations on riparian habitat; and threatened and endangered species are concerns directly attributed to hydropower development and operations. Development of new hydropower capacity, the uprating of existing facilities, and the reevaluation of existing operations will be accompanied by an environmental analysis that includes an appropriate balancing of uses. In the case of unavoidable impacts, measures will be taken to mitigate the adverse impacts of the proposed action while maintaining important species populations.

Activities that avoid or mitigate impacts of hydropower development and operations on fish and wildlife include the installation of multilevel water withdrawal structures to control temperature, dissolved oxygen, and turbidity of reservoir releases for cold water fisheries and spawning purposes; installation of fish ladders and screens for migrating fish; self-venting

turbines; special operations that allow larvae and juvenile fish to bypass turbines; maintenance of instream flows; construction of small afterbays to re-regulate flow releases; creation of tailwater habitat for fisheries; riverbank protection and stabilization; installation of plunge pool deflectors or modifications of reservoir operations to avoid supersaturation of gases in reservoir releases; and construction of fish hatcheries.

Hydropower development must also consider threatened and endangered species. Actions that address threatened and endangered species issues include the creation or restoration of critical habitat and development of species recovery plans. Species recovery plans may involve the propagation and rearing of threatened and endangered species, transplanting species to undeveloped stream reaches, and establishing sanctuaries or wildlife preservation areas.

Water Quality

A major factor influencing water quality in reservoir releases is thermal stratification. Thermal stratification and its associated density gradient directly influence how water flows through a reservoir, as well as other factors such as dissolved oxygen concentrations, temperature, and turbidity. This is especially important to hydropower operations because turbine intakes often withdraw water from the lower depths of the reservoir where the poorest quality of water may be found. Methods for dealing with low dissolved oxygen include hypolimnetic oxygen injection, self-venting turbines, air injection systems, baffles on the turbine hub or ring baffles on the draft tube wall, and/or modification of existing turbine venting system. Methods for dealing with temperature and turbidity problems include selective withdrawal structures.

Other water quality concerns associated with project operations include gaseous supersaturation and sediment transport and deposition. Gaseous supersaturation results from rapid temperature increases, rapid pressure decreases, and turbulent mixing of air with water under hydrostatic pressures. The supersaturation of gases in reservoir releases primarily relates to spillway discharges; this problem can be corrected by installing plunge pool deflectors or modifying reservoir operations. Sediment transport and deposition are best solved by developing better management practices and installing devices to control soil erosion. However, the release of sediment-free water deprives downstream environs of the silt needed to sustain riparian ecosystems, agricultural productivity, and the organic cycle that supports aquatic organisms.

Outdoor recreation and tourism are rapidly growing segments of our economy. Reclamation reservoirs and downstream reaches have significantly increased recreational opportunities such as cold-water sport fisheries and white-water rafting. When recreation and tourism involve reservoirs and stream reaches, conflicts often arise between recreational interests and water-dependent economic sectors (differing needs of recreation, power, municipal and industrial use, irrigation use, conservation storage, and flood control). Recreational considerations include establishing and maintaining minimum reservoir water elevations, establishing instream flows, determining the range of stream level fluctuations, ramping rates, and providing for public access and safety.

Comprehensive water resource management, development, protection, and the appropriate balancing of uses are the keys to resolving these multiple-use issues.

Hydroelectricity production and recreation are often compatible uses. During 1989, Reclamation produced enough power for 13.2 million people and attracted a record 79 million visitors seeking recreation activities such as rafting, boating, and fishing.

Opportunities abound for partnerships between hydroelectric and other interest groups. Reclamation has signed cooperative agreements with Trout Unlimited and Bass Anglers Sportsman Society to improve fisheries habitat.

Operating Considerations

A key challenge for Reclamation will be to increase the compatibility of existing and new hydropower developments with the environment while maximizing hydropower's contribution to the Nation's energy needs.

Environmental considerations may require operating constraints, possibly limiting the size or operation of future hydropower plants, or even prohibiting their construction, as well as reducing existing hydropower resources. Limits on power operations for the benefit of other resource uses can include:

- Minimum discharges for water supply, navigation, water quality, fish and wildlife, or recreation.
- Daily and hourly discharge fluctuation limits to protect navigation, recreation, fish and wildlife, and to prevent bank erosion.
- Maximum discharge limits to prevent flooding and bank erosion and to facilitate upstream fish migration.
- Forced releases to enhance downstream fish migration or to improve water quality.
- Fixed release schedules to improve conditions for fishing or to enhance river and/or reservoir-based recreation.

Flaming Gorge Powerplant, located on the Green River in Utah, began operation in 1963 and has three units with a total capacity of 108 MW. The powerplant is part of the Colorado River Storage Project which provides for comprehensive development of the Upper Colorado River Basin. The project furnishes the long-term regulatory storage needed to permit states in the upper basin to meet their flow obligation at Lees Ferry, Arizona, as defined in the Colorado River Compact.

Chapter Four

Implementing Reclamation's Energy Initiative

The significance of hydropower as a national energy resource must not be underestimated. Hydropower represents an important part of the energy solution because it is renewable and relatively clean. Hydroelectric power can and will continue to play a critical role in meeting the Nation's energy needs.

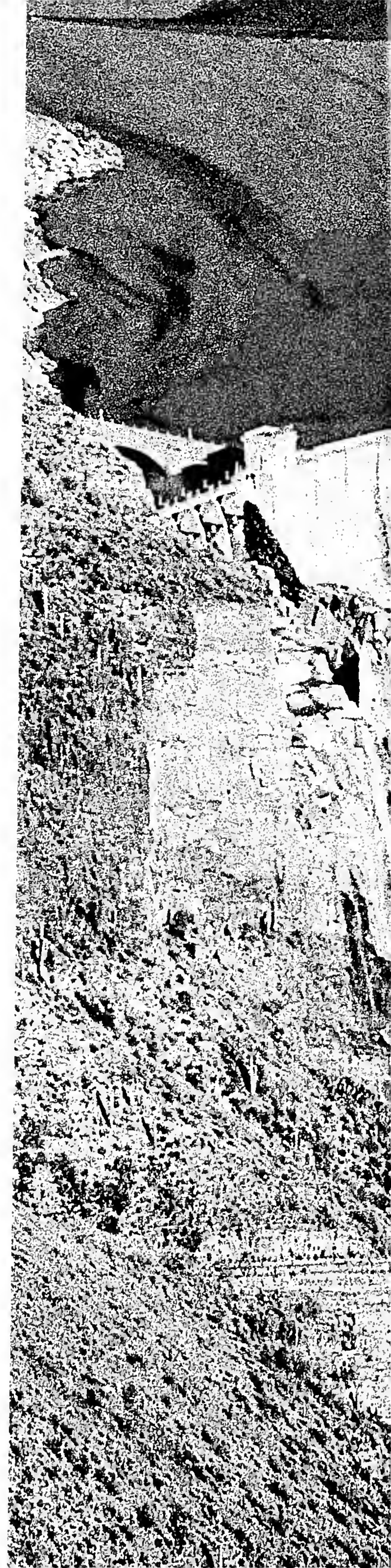
Theodore Roosevelt Dam was constructed by Reclamation and is operated and maintained by the Salt River Project. It was the first major structure completed on the Salt River Project. Located on the Salt River about 76 miles northeast of Phoenix, Arizona, the dam is a National Historic Landmark.

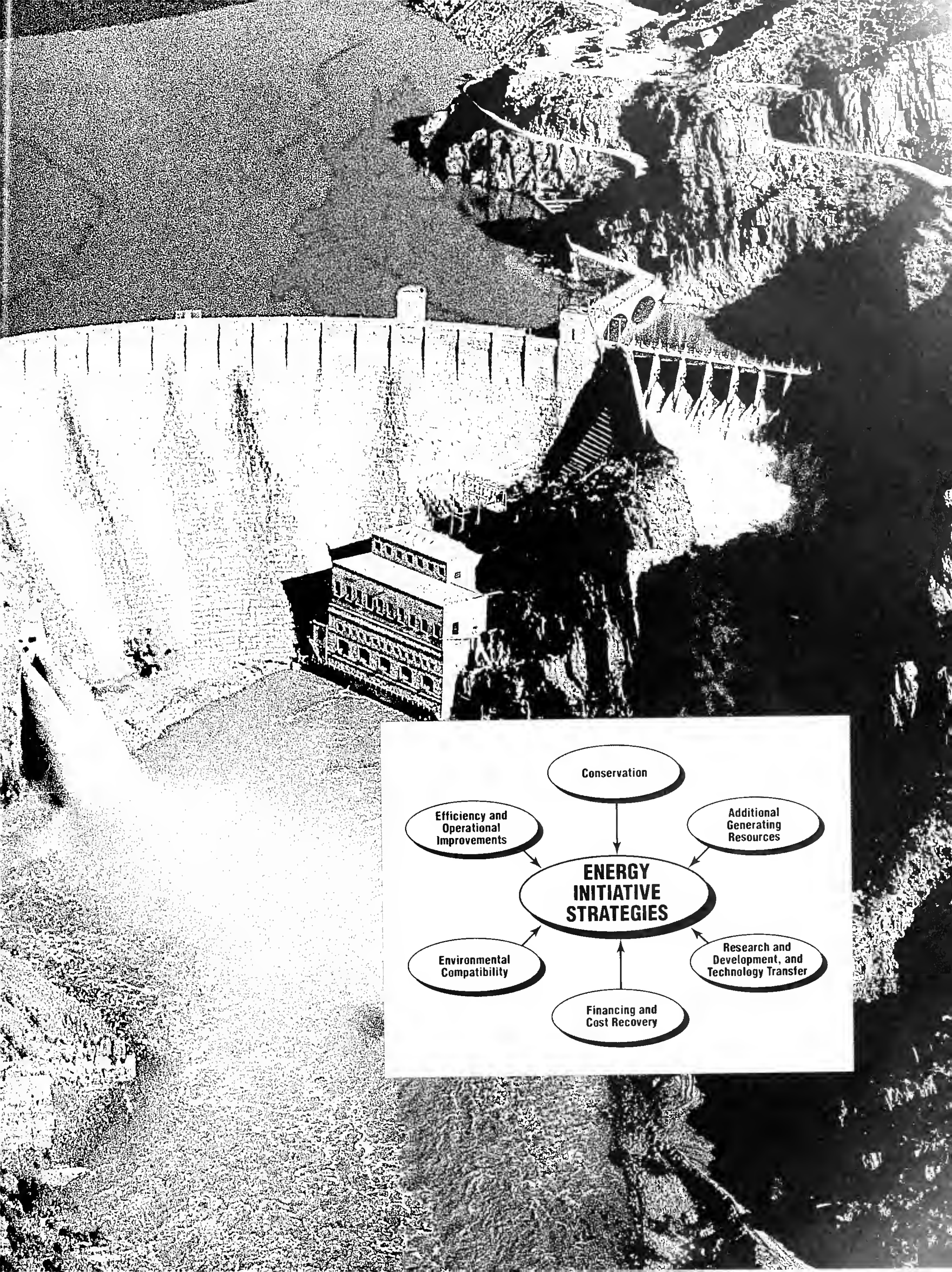
Implementation —The Commitment

[illegible] will promote awareness of energy issues and opportunities, accomplish individual [illegible] and enable Reclamation to be responsive to national energy and related economic and environmental needs.

HYDROPOWER 2002 is a broad, comprehensive initiative that complements Reclamation's *Strategic Plan*. It provides sufficient flexibility and foundation for accomplishing the six energy strategies described in this report. Execution of the Energy Initiative will ensure Reclamation's continued responsiveness to national energy and related economic and environmental needs over the next decade.

Reclamation is fully committed to furthering energy efficiency, conservation, and development programs that are environmentally and financially sound. As the Reclamation program is carried out, emphasis will be given to the projects and activities defined in this report. The following five-phase implementation process and schedule will guide the accomplishment of the energy strategies.





Conservation
Efficiency and Operational Improvements
Additional Generating Resources
ENERGY INITIATIVE STRATEGIES
Environmental Compatibility
Research and Development, and Technology Transfer
Financing and Cost Recovery

Develop assessment guidelines for six energy strategies.
Develop hydropower performance criteria.
Develop powerplant replacement program guidelines.
Review/update guidelines and performance criteria.

Solicit input from other Federal agencies, state/local entities, and the public on assessment of opportunities.
Evaluate energy strategy opportunities and existing energy-related activities.
Prioritize energy strategy opportunities and existing activities.

Conduct annual reviews of the Energy Initiative to assess accomplishments and make required adjustments.
Prepare biennial progress reports, including regional supplements enumerating specific Energy Initiative accomplishments.

Assess existing 52 powerplants relative to six energy strategies.
Assess current energy-related programs and activities.
Assess new opportunities relative to energy strategies.
Conduct periodic assessment audits.
Assess current financing and cost recovery methods.

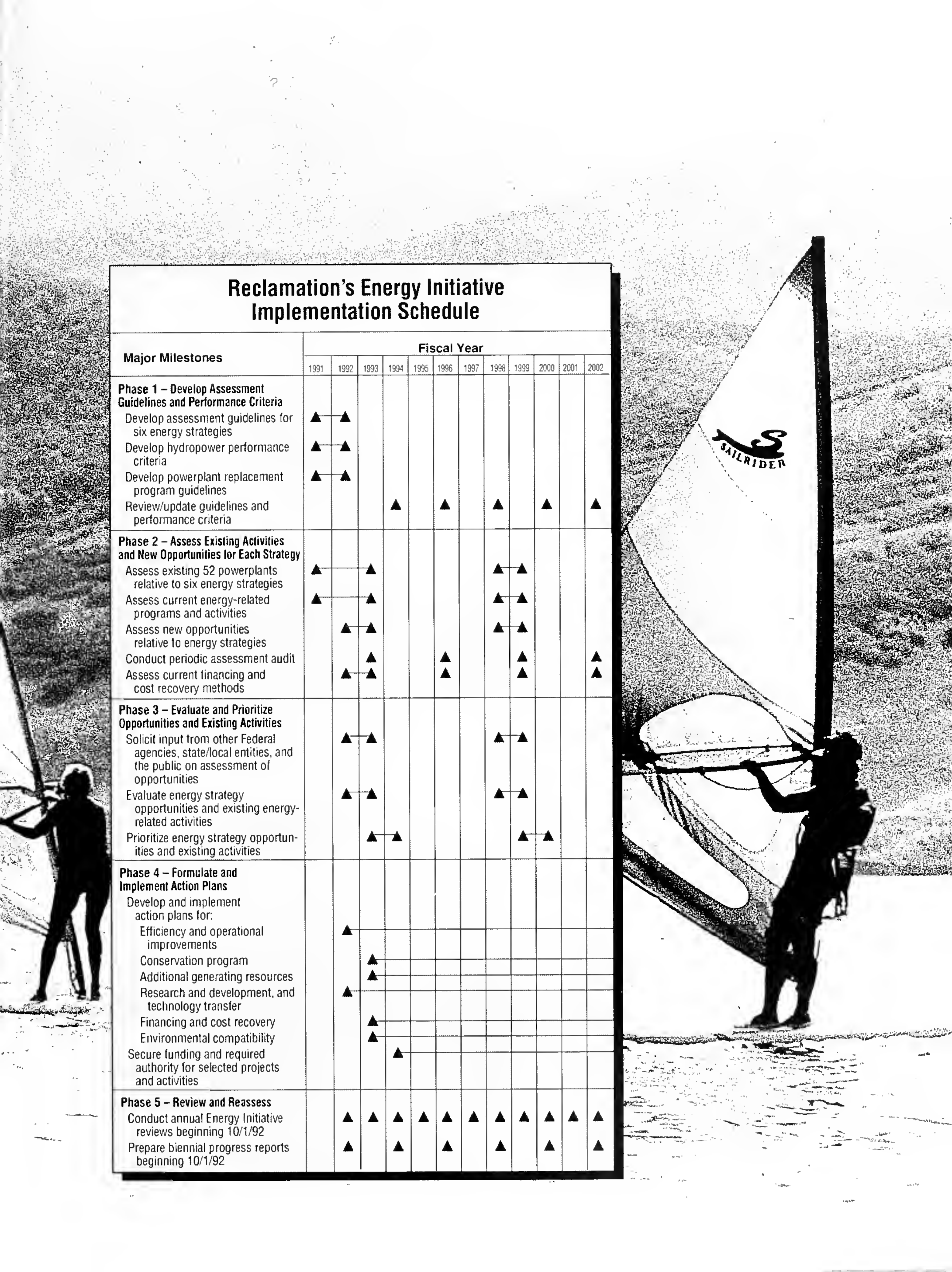
Develop and implement action plans for:

- Efficiency and operational improvements.
- Conservation program.
- Additional generating resources.
- Research and development, and technology transfer.
- Financing and cost recovery.
- Environmental compatibility.

Secure funding and required authority for selected projects and activities.

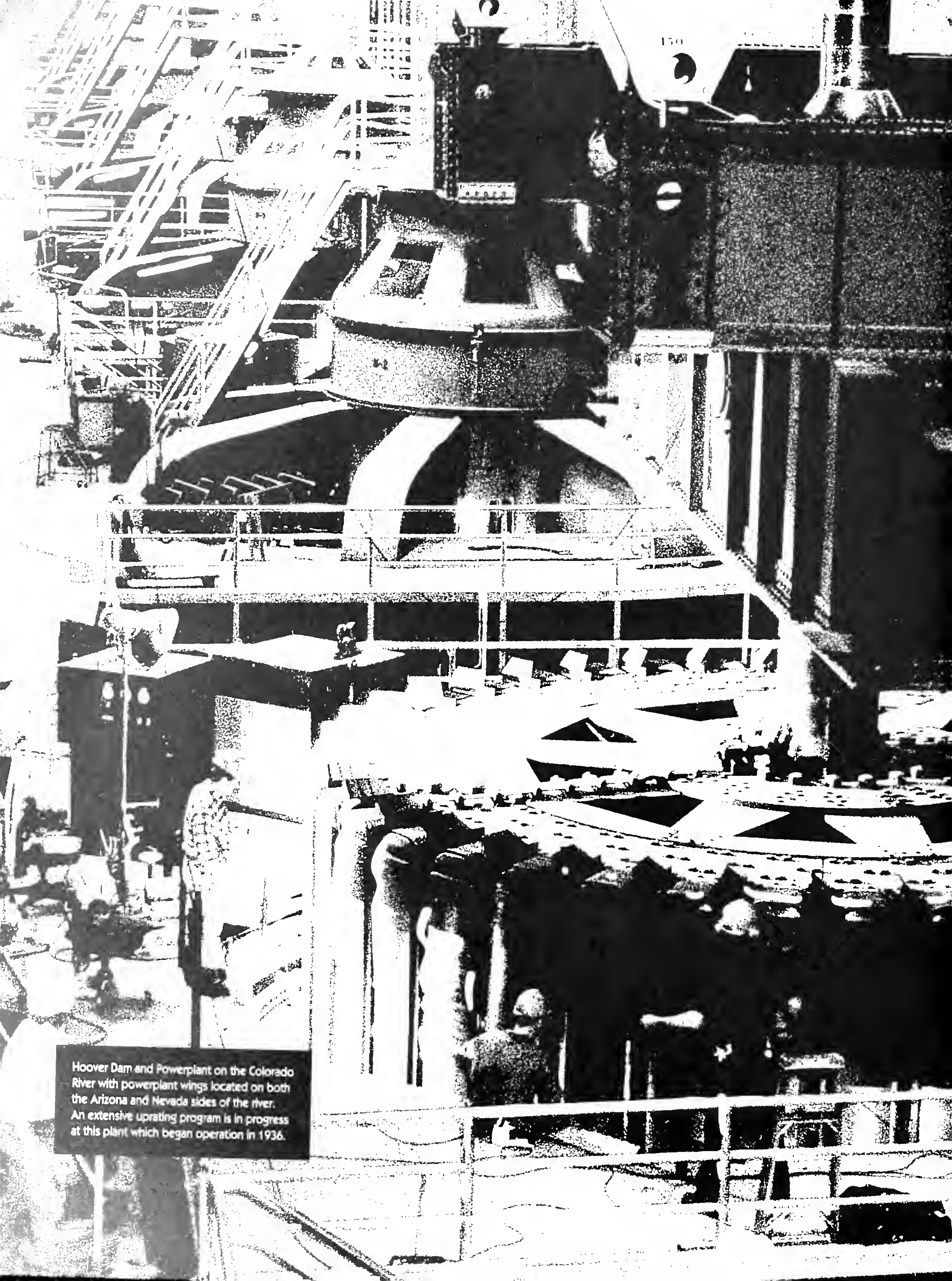
Organizational adjustments will be made, program policies and guidelines established, and an evaluation process implemented to ensure the most effective accomplishment of energy-related activities.

The following schedule illustrates the various types of projects and activities that will be carried out as Reclamation implements *HYDROPOWER 2002*.



Reclamation's Energy Initiative Implementation Schedule

Major Milestones	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
	Fiscal Year											
Phase 1 – Develop Assessment Guidelines and Performance Criteria												
Develop assessment guidelines for six energy strategies	▲	▲										
Develop hydropower performance criteria	▲	▲										
Develop powerplant replacement program guidelines	▲	▲										
Review/update guidelines and performance criteria				▲		▲		▲		▲		▲
Phase 2 – Assess Existing Activities and New Opportunities for Each Strategy												
Assess existing 52 powerplants relative to six energy strategies	▲	—	▲					▲	▲			
Assess current energy-related programs and activities	▲	—	▲					▲	▲			
Assess new opportunities relative to energy strategies		▲	▲					▲	▲			
Conduct periodic assessment audit			▲			▲			▲			▲
Assess current financing and cost recovery methods		▲	▲			▲			▲			▲
Phase 3 – Evaluate and Prioritize Opportunities and Existing Activities												
Solicit input from other Federal agencies, state/local entities, and the public on assessment of opportunities		▲	▲					▲	▲			
Evaluate energy strategy opportunities and existing energy-related activities		▲	▲					▲	▲			
Prioritize energy strategy opportunities and existing activities			▲	▲					▲	▲		
Phase 4 – Formulate and Implement Action Plans												
Develop and implement action plans for:												
Efficiency and operational improvements		▲	—	—	—	—	—	—	—	—	—	—
Conservation program			▲	—	—	—	—	—	—	—	—	—
Additional generating resources			▲	—	—	—	—	—	—	—	—	—
Research and development, and technology transfer		▲	—	—	—	—	—	—	—	—	—	—
Financing and cost recovery			▲	—	—	—	—	—	—	—	—	—
Environmental compatibility			▲	—	—	—	—	—	—	—	—	—
Secure funding and required authority for selected projects and activities				▲	—	—	—	—	—	—	—	—
Phase 5 – Review and Reassess												
Conduct annual Energy Initiative reviews beginning 10/1/92		▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
Prepare biennial progress reports beginning 10/1/92		▲		▲		▲		▲		▲		▲

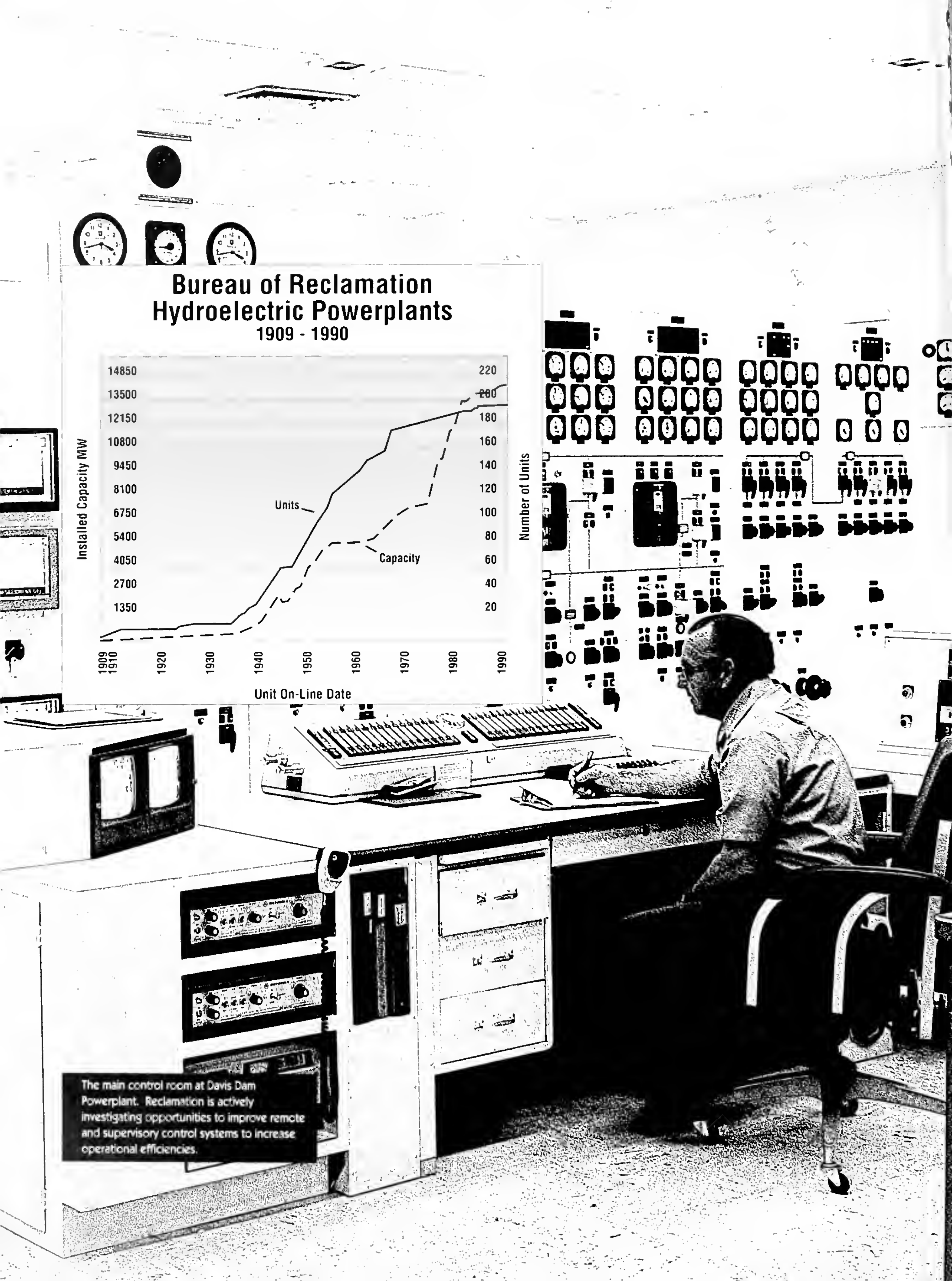


Hoover Dam and Powerplant on the Colorado River with powerplant wings located on both the Arizona and Nevada sides of the river. An extensive uprating program is in progress at this plant which began operation in 1936.

APPENDICES

RECLAMATION'S ENERGY INITIATIVE

...DERSHIP ROLE IN SUPPORTING OUR NATIONAL ENERGY STRATEGY.



The main control room at Davis Dam Powerplant. Reclamation is actively investigating opportunities to improve remote and supervisory control systems to increase operational efficiencies.

Reclamation's Leadership in Hydropower

The Reclamation Act of 1902 authorized the Secretary of the Interior to undertake certain water resource development activities in the Western United States. Under the 1902 Act, the Congress authorized construction of federally financed water projects to reclaim arid lands west of the 100th meridian by providing water for irrigation. In turn, the Secretary established the Reclamation Service within the U.S. Geological Survey to carry out these activities. The Reclamation Service was renamed the Bureau of Reclamation in 1923.

Reclamation has statutory responsibilities for comprehensive planning, development, and management of multipurpose water projects in the 17 Western States. Historically, the primary purposes of Reclamation projects have been irrigation; flood control; and water for domestic, industrial, and municipal use. Hydroelectric power generally has been a secondary purpose. Although not a primary objective, power is considered for inclusion in multipurpose Federal Reclamation projects when it is in the national interest, economically justified, feasible by engineering and environmental standards, and capable of repaying its share of the Federal investment in accordance with Reclamation law.

Electric power generated at Reclamation damsites was initially used to process materials as well as to construct the engineering works. The plants powered sawmills, concrete plants, cableways, hoists, giant shovels, and draglines; they also powered lights that facilitated round-the-clock operations at some damsites. Following completion of the construction, the energy-powered pumps provided drainage or conveyed water to lands unreachable by gravity canal systems. Under provisions of the Town Sites and Power Development Act of 1906, surplus power was sold to municipal and farm consumers and helped meet local industrial demands for electricity. The hydroelectric features were included in project construction costs repaid by the water and power users under provisions of the 1902 Reclamation Act.

The Secretary of the Interior has authority to develop the hydropower potential of Reclamation projects under the following acts:

Reclamation Act of 1902
Town Sites and Power Development Act of 1906
National Industrial Recovery Act of June 16, 1933
Reclamation Project Act of August 4, 1939
Flood Control Act of 1944
Small Reclamation Projects Act of 1956
Specific project authorizations

Reclamation's original purpose, "to provide for the reclamation of arid and semiarid lands in the West," now covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river regulation; improvements to navigation; fish and wildlife enhancement; recreation; and research in water management and alternative energy sources, such as wind and solar power. Reclamation also conducts basic research in design and construction techniques, and in materials used in water management structures. Reclamation programs involve close cooperation with the Congress, other Federal agencies, States, Indian Tribes, local governments, academic institutions, water user organizations, wildlife groups, recreation groups, conservation groups, and others.

Reclamation's development options for hydropower include:

Federal development using Congressionally appropriated funds.

Federal development using contributed funds pursuant to the Contributed Funds Act of March 4, 1921 (as amended).

Non-Federal development under a lease of power privilege contract.

Reclamation is not required to obtain licenses to construct or operate hydroelectric facilities; however, when using Federal funds, Congressional authorization is required to construct and operate the facilities.

Reclamation is the Nation's second largest producer of hydroelectric power, with 52 powerplants in operation having an installed capacity of 13,800 MW (Table A.1). Reclamation powerplants annually generate about 60 billion kWh of hydroelectric energy, enough to meet the annual residential needs of over 20 million people. The production of an equivalent amount of energy from thermal powerplants would require about 115 million barrels of oil.

When compared with all electric utilities, Reclamation ranks as the 11th largest "utility" in the United States. Table A.2 ranks the 20 largest utilities in the United States having generating facilities. (A map showing the location of Reclamation power facilities appears in Appendix G.)

Reclamation Hydroelectric Resources Summary FY 1990

Reclamation Region	Number of power plants	Number of units	Installed capacity (kW)	% Recla-mation	Gross generation (kWh)	% Recla-mation
Pacific Northwest	10	59	7,010,317	50.8	25,575,779,925	60.9
Lower Colorado	3	28	2,290,000	16.6	5,937,146,000	14 1
Mid-Pacific	11	40	1,845,820	13.4	3,518,890,890	8.4
Upper Colorado	10	24	1,683,334	12.2	4,698,928,900	11.2
Great Plains	18	39	964,500	7.0	2,280,560,141	5.4
TOTAL	52	190	13,793,971	100	42,011,305,856	100

Table A.1

Rank	Utility Name	Capacity (kW)
1	Tennessee Valley Authority	30,930,900
2	Commonwealth Edison Company	24,733,700
3	Georgia Power Company	20,792,500
4	Corps of Engineers	20,625,900
5	Texas Utilities Electric Company	19,874,600
6	Duke Power Company	17,354,200
7	Houston Lighting and Power Company	16,815,800
8	Southern California Edison Company	15,720,400
9	Pacific Gas and Electric Company	15,372,800
10	Florida Power and Light Company	14,876,100
11	**Bureau of Reclamation**	**13,794,000**
12	Virginia Power	13,479,600
13	Detroit Edison Company	11,511,600
14	Alabama Power Company	11,449,800
15	Carolina Power and Light Company	10,842,100
16	Public Service Electric and Gas Company	10,835,900
17	Philadelphia Electric Company	9,378,700
18	Consolidated Edison Company	9,176,800
19	Pacific Power and Light Company	8,960,200
20	Arizona Public Service Company	8,803,600

Most Reclamation power projects have been entirely financed, constructed, and operated by the Bureau itself; however, alternative arrangements are occasionally made through the non-Federal sector. Twenty-four powerplants are operated by the project entities under lease-of-power-privilege contracts and other agreements with Reclamation. These 24 facilities represent 747 MW (see Appendix D).

When Federal power is not authorized at a specific Reclamation project site, FERC may also license powerplants for construction by non-Federal entities. Licenses for these plants are issued by FERC pursuant to the Federal Power Act. Currently, 28 FERC-licensed hydropower projects are operating at Reclamation facilities, representing a capacity of 368 MW. Additional projects, representing about 88 MW, are under construction or in the project design stage. (See Appendix E for a list of FERC-licensed projects.)

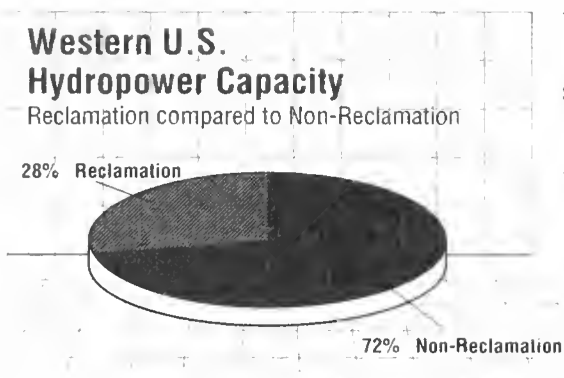


Figure A.1

Figure A.1 shows the relative amount of hydroelectric capacity in the Western States created by Reclamation. Figure A.2 shows the distribution of Reclamation hydropower capacity in 10 Western States and the percent of Western hydroelectric capacity operated by Reclamation.

Reclamation's only current participation in thermal-electric generation is its 24.3-percent share of output from the Navajo Generating Station at Page, Arizona. Reclamation's participation in the Navajo plant supplies electricity to pumps of the Central Arizona Project. Reclamation's share amounts to 547 MW of the plant's capacity.

While power represents only one of Reclamation's missions, it is a key element in the overall Reclamation program. At present, revenues from the sale of power are $700 million annually. Over the years, these power revenues represent more than $6 billion in project repayment to the Federal Treasury. Although power generally is not considered a primary project purpose, power revenues will be responsible for repayment of more than 90 percent of Reclamation project costs. In addition, Reclamation's power program is responsible for more than $2 billion of physical assets used in Federal hydropower production.

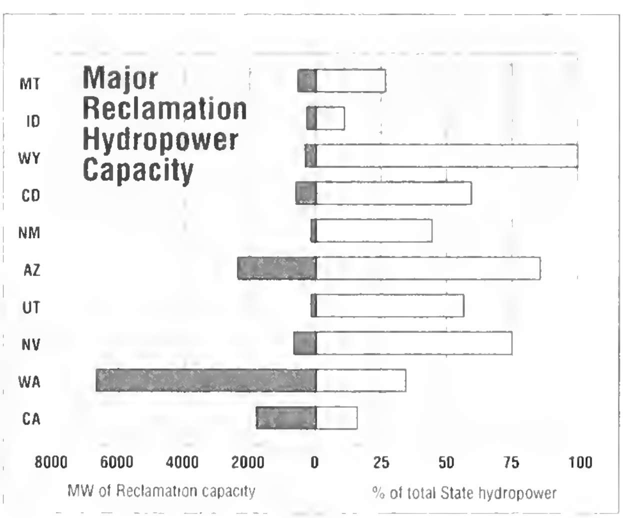


Figure A.2

A full range of services and activities are necessary to accomplish Reclamation's mission as a leading supplier of hydroelectric power and energy. Table A.3 shows Reclamation's involvement in various phases of power activities.

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Planning
Project use power
Research and development
Statistics
Environmental studies
FERC coordination
Design
Training
Construction
Foreign activities
Operation
Safety
Maintenance
Western Systems Coordination Council
Management
Technology transfer
Communications
Electric Power Research Institute
Power contracts
American Public Power Association
Repayment
Interagency research coordination
Power Marketing Administrations
Power pools

Electricity produced at Reclamation facilities is used either internally at projects or sold as firm and excess power. The primary internal use is for delivering water. Excess power is marketed by Federal PMA's. The Federal PMA's market firm power at the lowest possible rates consistent with sound business practices. Preference for firm power contracts is given to municipalities, public corporations, public agencies, and cooperatives or other nonprofit organizations. In addition to contracts for firm power, PMA's also market excess hydropower from Reclamation facilities on an "as available" basis (generally nonfirm).

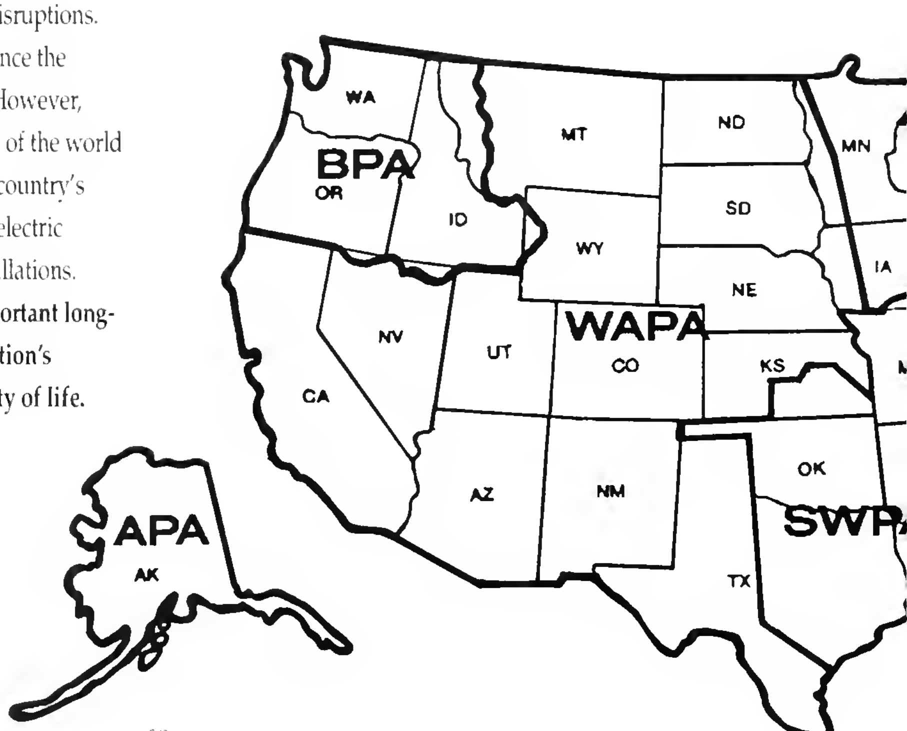
Revenues from power sales are used to repay project costs. In addition, power revenues also repay portions of other project costs, such as salinity control and irrigation.

Hydropower has an important role in buffering the Nation from energy emergencies, such as oil import disruptions. Fluctuations in petroleum and natural gas costs influence the economic and military security of the United States. However, hydroelectric powerplants are not subject to the whim of the world oil market. They are a major force in minimizing our country's vulnerability to outside influence. Reclamation hydroelectric powerplants supply electric power to 28 military installations.

All hydroelectric powerplants play an important long-term role with wide-ranging implications for the Nation's security, energy self-sufficiency, economy, and quality of life.

Coordination activities and day-to-day contacts with other Federal agencies and public and private electrical energy interests are an extensive and integral part of Reclamation's power program. It is imperative that Reclamation maintain a strong and close working relationship with organizations involved in the power industry to ensure the best use and coordination of Reclamation hydropower resources.

U.S. Department of Energy. The U.S. Department of Energy was established in October 1977. It consolidated the activities of the Energy Research and Development Administration, the Federal Power Commission, the Federal Energy Administration, the power marketing function of Reclamation, and some elements of other agencies. The new department was assigned wide-ranging powers to set energy prices, enforce conservation measures, and allocate fuel; it also was empowered to engage in research on new sources of energy.



Federal Power Marketing Administrations. Reclamation will continue to closely coordinate with the Federal PMA's. Reclamation's excess energy is marketed through the Bonneville Power Administration and Western Area Power Administration.

Bonneville Power Administration (BPA). The Administration was created pursuant to the act of August 20, 1937. Through a region-wide, interconnecting transmission system, it markets electric power and energy from Federal hydroelectric projects in the Pacific Northwest constructed and operated by the U.S. Army Corps of Engineers and Reclamation. Through interregional connections, it sells surplus power to areas outside the Pacific Northwest region and participates in exchanges of power. BPA markets power produced by the Federal Columbia River Power System.

The utilities and Federal agencies in the Pacific Northwest have historically coordinated system operations and planning under terms of the Northwest Coordination Agreement and the Canadian Treaty. The Pacific Northwest Electric Power Planning and Conservation Act (Regional Act) was enacted December 5, 1980. This Act provides the format and criteria for planning and operating hydropower resources for utilities and Federal agencies that will result from the Power Planning Council.

BPA's role was expanded considerably by this Act to include conservation and enhancement of anadromous fish runs, with conservation stressed as a means of reducing future power needs. The Regional Council provides system load forecasts for power planning purposes.

By Act of October 18, 1974 (16 U.S.C. 838), the BPA has the authority, in lieu of appropriations, to use its revenues and sell revenue bonds to the U.S. Treasury to finance its programs.

POWER MARKETING ADMINISTRATIONS

APA
Alaska Power Administration

BPA
Bonneville Power Administration

SEPA
Southeastern Power Administration

SWPA
Southwestern Power Administration

WAPA
Western Area Power Administration

Western Area Power Administration (Western). Created under the Department of Energy Organization Act, Western was established on December 21, 1977.

Western markets and transmits Federally produced power in 15 Central and Western States. Western's customers in this 1.3 million-square-mile geographic area include cooperatives, municipalities, public utility districts, investor-owned utilities, Federal and State agencies, irrigation districts, and project use customers. These 572 wholesale power customers provide service to millions of retail consumers in California, Nevada, Montana, Arizona, Utah, New Mexico, Texas, North Dakota, South Dakota, Iowa, Colorado, Wyoming, Minnesota, Nebraska, and Kansas. Western operates and maintains more than 16,200 miles of transmission lines, 240 substations, and other associated power facilities.

Hydroelectric power marketed by Western is generated by 49 powerplants operated by Reclamation, the U.S. Army Corps of Engineers, and the International Boundary and Water Commission (U.S. Section). Western also markets a portion of the power generated by the large Navajo coal-fired plant. The current maximum operating capability of these powerplants is 9,930 MW.

Federal Energy Regulatory Commission (FERC). FERC was established in 1977 (replacing the Federal Power Commission) with the primary responsibility of ensuring the Nation's consumers adequate energy supplies at just and reasonable rates and providing regulatory incentives for increased productivity, efficiency, and competition. Its primary functions are to establish and enforce interstate rates and regulations of the electric, natural gas, and oil industries. It also issues licenses for non-Federal hydroelectric plants and certifies small power production and cogeneration facilities.

Reclamation formulates and develops policies, objectives, standards, and procedures for conducting Reclamation's FERC-related activities. These activities are essential to ensure that the purposes for authorizing and constructing Reclamation projects are preserved and protected in proceedings before FERC. Reclamation will continue to identify the need for and will develop Reclamation instructions, policies, guidelines, and proposed legislation to comply with current and developing FERC policies.

US Army Corps of Engineers

U.S. Army Corps of Engineers (COE). COE is charged with building both military and civilian facilities. Placed in charge of U.S. seaports and inland waterways in 1824, COE has since built dams, reservoirs, harbors, and lighthouses, and is the agency primarily responsible for planning and constructing major flood control projects.

COE is also involved in the planning, construction, and operation of hydroelectric power facilities. Reclamation coordinates activities with COE in areas of mutual interest.

Tennessee Valley Authority (TVA). TVA is an agency of the United States designed to foster development in the Tennessee River Valley and certain adjacent areas located in Tennessee, North Carolina, Virginia, Georgia, Alabama, Mississippi, and Kentucky. TVA, established in May 1933, was given general authorization for the planning, construction, and operation of dam and reservoir projects for the primary purposes of navigation and flood control, and also operation of the projects for the generation of electricity. TVA also was authorized to sell electric power and has extensive thermal (both coal and nuclear) generation facilities as well as hydroelectric resources.

TVA's dams form an integrated system that aids flood control on the Tennessee, Ohio, and Mississippi Rivers. As of early 1986, TVA's system consisted of 50 dams, 40 in the integrated water control system, and 10 nonpower dams. Of the 40 power dams, 34 were owned by TVA and 6 were operated by TVA, but owned by ALCOA, Inc. TVA also directs the operation of nine dams in the Cumberland Basin, one owned by TVA, the remainder by COE. Others are operated in the Tributary Area Development Program of the TVA.

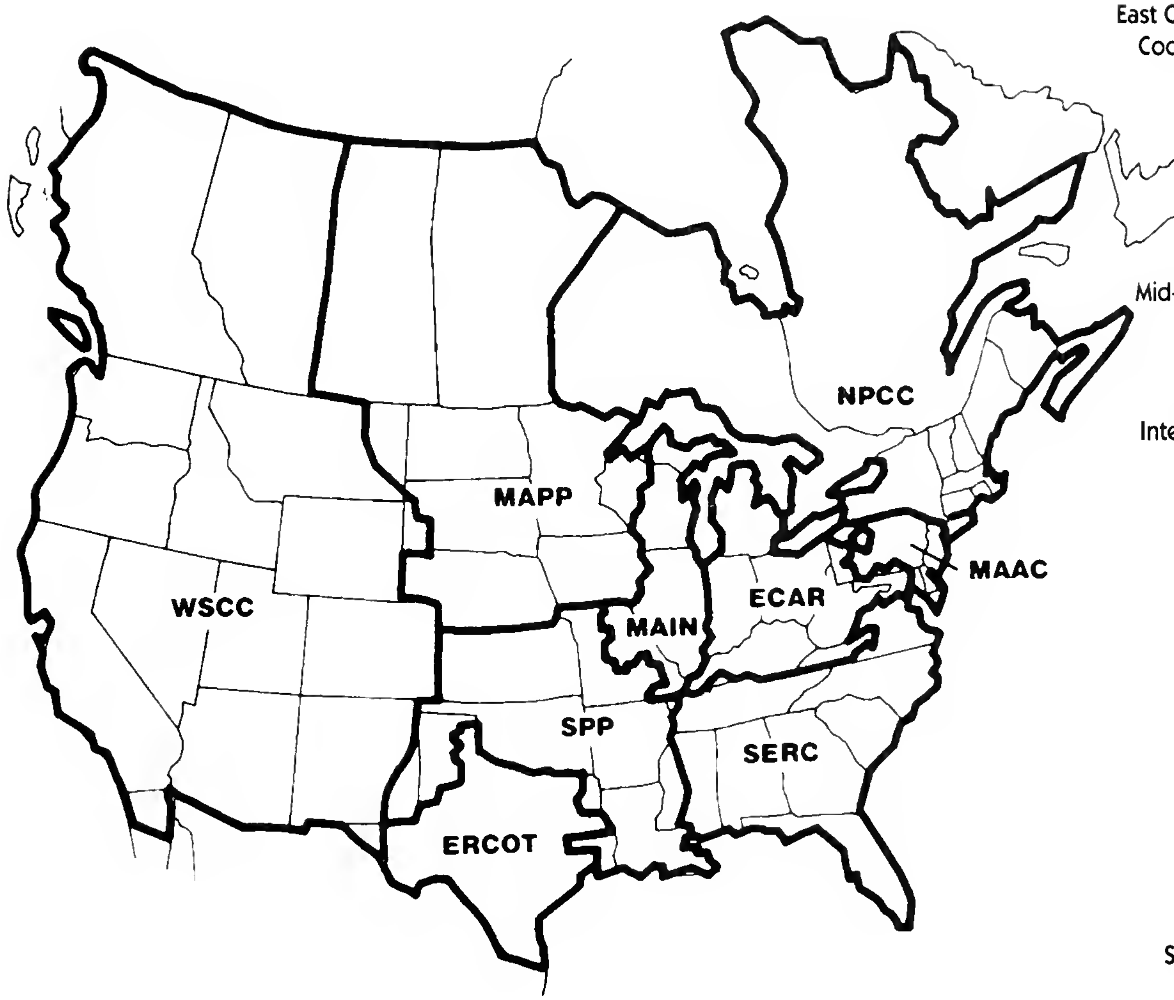
North American Electric Reliability Council

Reliability Councils. Reliability councils were organized to promote bulk power system reliability through coordinated planning and operations. Nine regional reliability councils comprise the North American Electric Reliability Council, which encompasses the contiguous United States and portions of Canada and Mexico. The regional councils are:

East Central Area Reliability Coordination Agreement
Electric Reliability Council of Texas
Mid-Atlantic Area Council
Mid-American Interconnected Network
Mid-Continent Area Power Pool
Northeast Power Coordinating Council
Southeastern Electric Reliability Council
Southwest Power Pool
Western Systems Coordinating Council

NORTH AMERICAN ELECTRIC RELIABILITY COUNCIL

Figure A.3



ECAR
East Central Area Reliability Coordination Agreement

ERCOT
Electric Reliability Council of Texas

MAAC
Mid-Atlantic Area Council

MAIN
Mid-America Interconnected Network

MAPP
Mid-Continent Area Power Pool

NPCC
Northeast Power Coordinating Council

SERC
Southeastern Electric Reliability Council

SPP
Southwest Power Pool

WSCC
Western Systems Coordinating Council

Western Systems Coordinating Council (WSCC). Reclamation is a member of the WSCC, which includes 62 electric utility systems and 3 affiliate systems. The WSCC members provide nearly all the electric service in the States of Washington, Oregon, California, Arizona, New Mexico, Nevada, Utah, Idaho, Montana, Wyoming, and Colorado; as well as portions of South Dakota, Nebraska, Texas, the Canadian provinces of British Columbia and Alberta, and the northern portion of one Mexican state.

Reclamation actively participates on WSCC committees and work groups to promote bulk power system reliability through coordinated planning and operation. An Executive Committee guides the activities of the four following WSCC standing committees:

Planning Coordination	*Operations*
Environmental	*Public Information*

Reclamation is represented on all of these committees.

Electric Power Research Institute (EPRI). EPRI is an independent, private, nonprofit corporation supported by U.S. investor-owned cooperative, municipal, and Federal utilities through voluntary membership payments. EPRI's mission is to manage an industry-wide research and development program; provide leadership in the innovation, integration, and application of new technology; and provide scientific and technical support to its members. Reclamation is an active member of EPRI through a cooperative arrangement with Western. Reclamation participates on various task forces and committees to support and guide EPRI's energy research and development programs.

American Public Power Association (APPA). APPA is the service organization for the Nation's community-owned, not-for-profit electric utilities providing the electric power needs of 35 million Americans. APPA was created in 1940 as a not-for-profit, nonpartisan organization to advance the public policy interests of its members and their consumers, and to provide services to help ensure adequate, reliable electricity at a reasonable price with proper protection of the environment. Most public power systems are owned by municipalities, with others owned by States, counties, or public utility districts. Public power consumers are utility owners as well as electricity users, with local control over policy and service in public hands. APPA is governed by a 36-member, regionally representative board of directors.

National Water Resources Association (NWRA). NWRA is a nonprofit federation of local and state agencies, individuals, industries and commercial firms, irrigation and conservation districts, and other water management entities.

NWRA is dedicated to promoting the wise management, conservation, and beneficial use of the nation's water resources. To accomplish this mission, NWRA promotes wise water and land policies; recognizes attendant economic and ecological effects; preserves the responsibilities and rights of individuals and organizations in encouraging beneficial use of water; and strives to achieve equitable allocation of costs to develop, conserve, and protect water and land resources for the national good.

National Rural Electric Cooperative Association (NRECA). The mission of NRECA is to serve, represent, and provide leadership to cooperative/consumer-owned rural electric systems and allied organizations in their efforts to enhance the quality of life in their communities. NRECA represents approximately 1,000 cooperative rural electric systems throughout the Nation.

Power Pools. Reclamation actively participates in several power pools where electrical systems are interconnected and operate on a coordinated basis to achieve economy in supplying combined system load. The degree of participation varies depending on the power pools' organization principles.

Significant Legislation Affecting Hydroelectric Power Development

Date	Law	Related Purpose
1902	**Reclamation Act**	Authorized Secretary of the Interior to develop irrigation and hydropower projects in the 17 Western States
1906	**Town Sites and Power Development Act**	Authorized Secretary of the Interior to lease surplus power or power privileges
1916	**National Defense Act**	Authorized Wilson Dam at Muscle Shoals, Alabama
1920	**Federal Water Power Act**	Regulated hydroelectric development of navigable waterways
1928	**Boulder Canyon Project Act**	Authorized construction of Hoover Dam
1933	**Tennessee Valley Authority Act**	Created TVA
1935	**Rivers and Harbors Act**	Authorized Grand Coulee Dam for construction
1937	**Bonneville Project Act**	Created Bonneville Power Administration
1939	**Reclamation Project Act**	Extended the contract term to 40 years for sale of power or lease of power privileges, giving preference to public entities
1944	**Flood Control Act**	Authorized Secretary of the Interior to market power from COE projects and authorized the Pick-Sloan Missouri Basin Program
1956	**Colorado River Storage Project Act**	Authorized water and power development in the States of the Upper Colorado River Basin
1959	**TVA Act Amendments**	Authorized TVA to issue revenue bonds
1968	**Wild and Scenic Rivers Act**	Protects rivers in their natural state by excluding them from consideration as hydroelectric power sites

Date	Law	Related Purpose
1969	National Environmental Policy Act	Ensures that environmental considerations are systematically taken into account by Federal agencies
1973	Endangered Species Act	Protects listed endangered species and their critical habitat
1974	Federal Columbia River Transmission System Act	Authorized BPA to issue revenue bonds
1974	Fish and Wildlife Coordination Act	Ensures equal consideration of fish and wildlife protection in the activities of Federal agencies
1977	Department of Energy Organization Act	Transferred existing Power Marketing Administrations to the DOE and created Western Area Power Administration
1977	Clean Water Act, Sections 401 and 404	Ensured Federal and non-federal compliance with State water quality standards and regulates water quality impacts of dredging and filling
1978	Public Utility Regulatory Policies Act	Encourages small-scale power production facilities; exempted certain hydroelectric projects from Federal licensing requirements, and required utilities to purchase — at "avoided cost" rates — power from small production facilities that use renewable resources
1980	Energy Security Act	Exempted small-scale hydroelectric power from some licensing requirements
1980	Pacific Northwest Electric Power Planning and Conservation Act	Authorized BPA to plan for and acquire additional power resources
1980	Crude Oil Windfall Profit Tax Act	Provided tax incentives to small-scale hydropower producers
1984	Hoover Power Plant Act	Allocated post-1987 Hoover power and authorized Hoover Powerplant uprating
1986	Electric Consumers Protection Act	Amended the Federal Power Act to remove public preference for relicensing actions; gives equal consideration to non-power values (e.g., energy conservation, fish, wildlife, recreation, etc.) as well as to power values when making license decisions

POWER UPRATING PROGRAM

The 1973 oil embargo initiated a review of Reclamation's powerplants to determine if uprating would produce more energy. Uprating existing hydroelectric powerplants to optimize the available water resource for additional energy and peaking capacity was recognized as one of the better long-range additions to aid in solving the energy problem. In 1978, Reclamation and the Department of the Interior began a major program to investigate and implement all viable opportunities to improve existing plants by modernizing and uprating generating equipment. **The Western Energy Expansion Study (1977) identified several proposals for uprating existing Reclamation hydroelectric units and concluded that uprating of existing units was the most immediate, cost-effective, and acceptable means of contributing to meeting the Nation's electric capacity and energy needs.** A General Accounting Office study entitled "Power Production at Federal Dams Could Be Increased by Modernizing Turbines and Generators" recommended that Reclamation evaluate opportunities to improve hydropower production and act on those economically justified. Because Reclamation's generator units average 37 years in age (Figure C.1), many generators are candidates for rewinding and/or uprating.

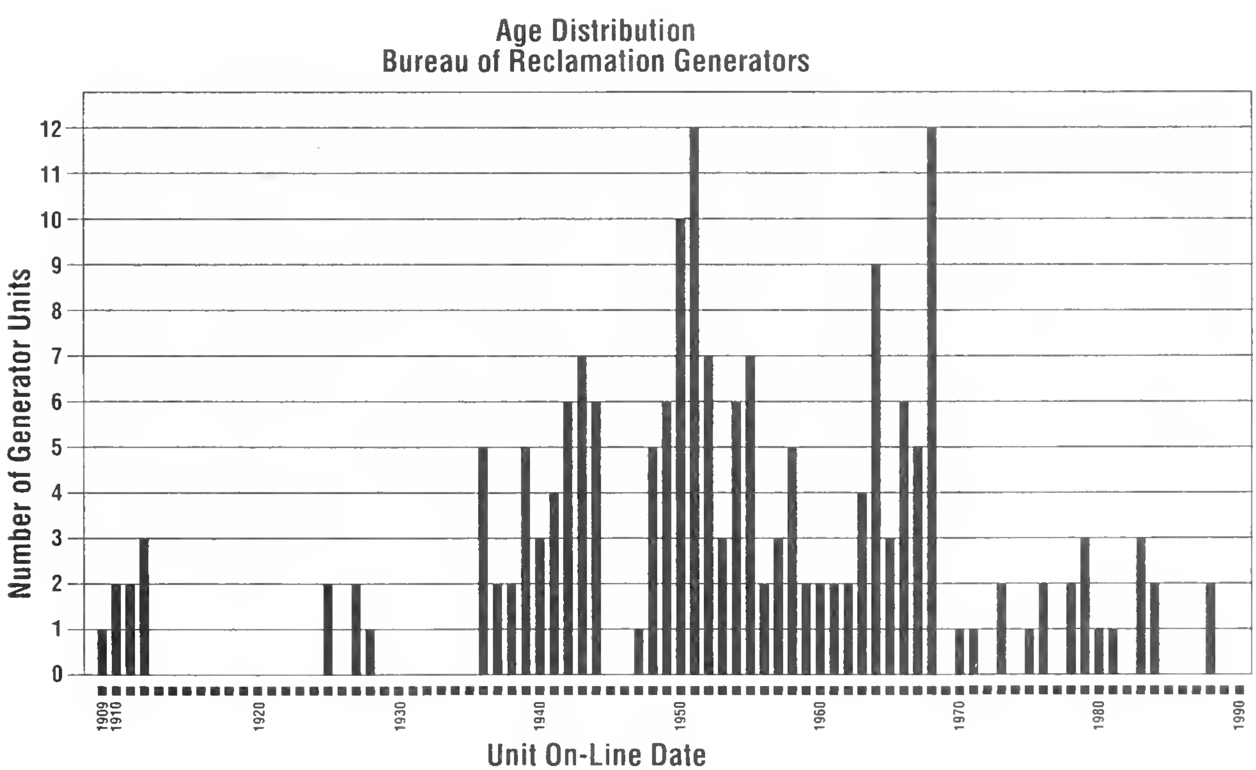


Figure C.1

Some confusion has existed about the terms "rewind" and "uprate," as applied to generators. Reclamation's definitions follow:

Rewind. Many of Reclamation's older generators were purchased with a continuous overload capability of 15 percent above manufacturer's rated output. To rewind a generator, the new winding generally is purchased with a base rating equal to the 115-percent machine level and at the appropriate allowable temperature rise consistent with the insulation class of the new winding. Although the new winding may be capable of operating at higher levels, the machine is limited to operation at the 115-percent level because the mechanical characteristics of the generator have not been confirmed to be capable of higher loads. Ratings of the bus, transformer, and other parts are examined, but a detailed study is not performed.

Uprate. Normally, an uprate involves an increase in rating of more than 15 percent which, in turn, necessitates a review of the capability and limits of all electrical and mechanical equipment—from the penstock through the turbine, generator, bus, switchgear, transformer, and transmission system. These systems can be retained, modified, or replaced to obtain the optimum uprate capacity.

A good indicator for considering uprating a generator occurs when turbine capacity substantially exceeds that of the generator at normal operating heads. Most Reclamation turbines are designed to provide rated output (or nameplate) at rated head. Since reservoirs often are at heads much higher than rated, the turbine is usually capable of more mechanical output than the generator can convert to electrical energy. In other situations, increased rating and efficiency can be obtained by runner replacement. For pre-1960 turbines, it is frequently possible to obtain output increases as high as 30 percent and efficiency increases of 1 percent by replacing existing runners with runners of improved design.

Modern developments in insulation technology provide the capability to manufacture windings of increased electrical capacity which are the same physical size as original manufactured windings. Therefore, it is often possible to increase the capacity of older units by installing new stator windings and improved runners, and by upgrading various auxiliary equipment.

Apart from technical limitations, the economic value of capacity is most important in justifying an uprate. Because many Reclamation projects develop the maximum energy available (without spillway operation) additional energy is not generated after an uprate. Uprated capacity is obtained at the expense of plant factor (energy can be produced at a higher level but for a lesser period of time). The practical limit of uprating is reached when the cost of replacing equipment to obtain additional capacity equals the economic worth of that added capacity.

Other considerations to be addressed when conducting a unit uprate study are:

Water operations
Power operations
Environmental considerations
Contractual obligations
Coordination and scheduling of the generator outage

The need for replacement power caused by the generator being out of service during the uprate work may impact a power system from an economic standpoint. The increased hydraulic losses from higher water velocities also should be examined. Actual annual energy output may decrease with an uprated power output. An economic evaluation is required to determine if the additional generation capacity from uprating is justified.

[illegible]

The power uprating program is subject to National Environmental Policy Act (NEPA) compliance. This compliance can take three forms:

1. A categorical exclusion (CE)
2. A Finding of No Significant Impact (FONSI)
3. An Environmental Impact Statement (EIS)

Each proposed rewinding / uprating must be evaluated by using a CE checklist to determine if it qualifies for the exclusion; if not, an Environmental Assessment (EA) is prepared and either a FONSI or EIS must be completed before the action is undertaken.

In cases where no change in operation occurs as a result of the actions, a CE will probably be appropriate. However, where flow modifications occur, the U.S. Fish and Wildlife Service and the State game and fish agency along with other interested agencies and organizations must be consulted and allowed to make recommendations on the proposed action. Such changes in flows could necessitate an EA which could result in a FONSI or an EIS if changes result in significant effects.

[illegible]

Uprating studies have been performed on 55 Reclamation generators. As of January 1, 1991, generator uprates have been completed on 34 units for an increase in Reclamation generating capacity of 1,137,440 kW. There are 21 units under contract or being negotiated to be completed between 1991 and 1995, for an additional 466,049 kW of capacity, for a total increase of 1,603,489 kW. Tables C.1 and C.2 show the present status of Reclamation's uprate program.

Figure C.1 shows the percent increase in capacity for completed generator uprates and Figure C.2 shows the uprate increase for uprates presently under contract.

Table C.1. [illegible]

Plant	Units	Old Rating (kW) Each Unit	New Rating (kW) Each Unit	Percent Change	Additional Kilowatts	Year Uprated
Shasta	2	75,000	125,000	66.7%	100,000	1978 & 1980
Anderson Ranch	2	13,500	20,000	48.1	13,000	1983
Flatiron	2	31,500	43,020	36.6	23,040	1983
Glendo	2	12,000	19,000	58.3	14,000	1983 & 1984
Hoover	10	82,500	130,000	57.6	475,000	1982-1989
Hoover	2	82,500	127,000	53.9	89,000	1982-1989
Blue Mesa	2	30,000	43,200	44.0	26,400	1988
Fremont Canyon	2	24,000	33,400	39.2	18,800	1988 &1989
Trinity	2	50,000	70,000	40.0	40,000	1984
Glen Canyon	4	118,750	157,050	32.2	153,200	1984-1987
Glen Canyon	4	118,750	165,000	38.9	185,000	1984-1987
TOTAL	34			47.2%	1,137,440	

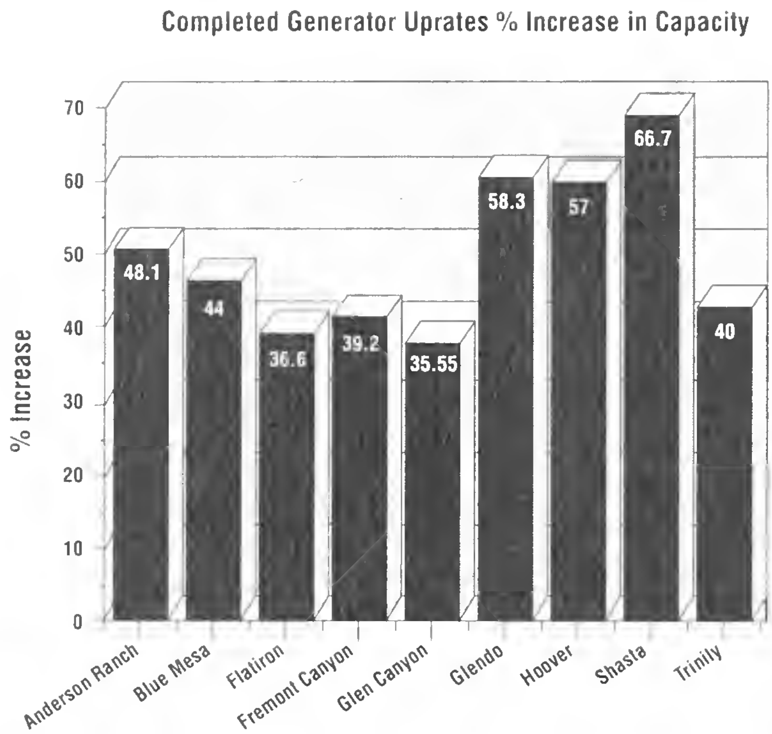


Figure C.2

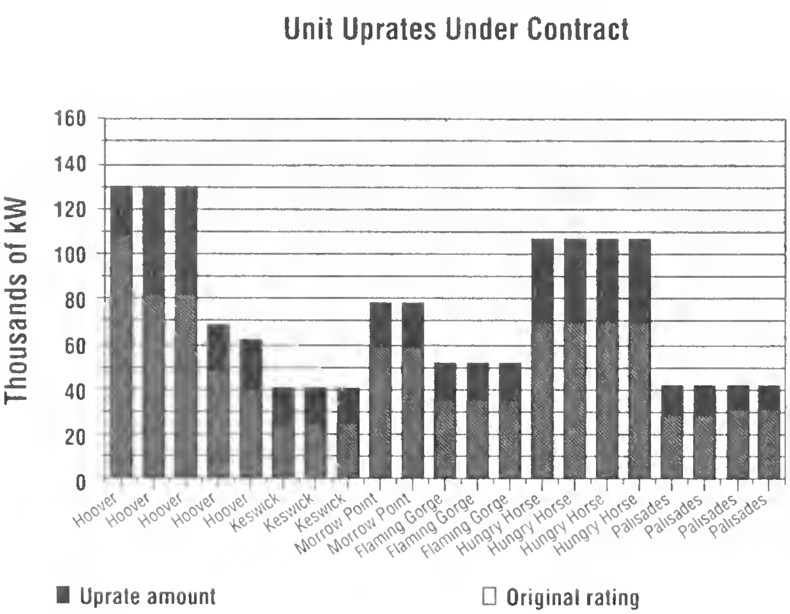


Figure C.3

Reclamation's Power Uprating Program is funded by both non-Federal and appropriated Federal funds. Money invested in the uprate program is completely reimbursed, with interest, through power revenues. Since 1978, total contract costs for the Power Uprating Program have been almost $100 million. Estimated contract costs for the 21 generators presently planned for uprating are about $54 million, for a total cost of $154 million.

Table C.3 shows the cost per kilowatt increase for 13 Reclamation uprating contracts involving 9 powerplants and 34 generating units. Figure C.4 shows the uprate increase and cost per kilowatt for all completed and under contract generator uprates. The numbers are actual costs of the contracts and have not been adjusted to reflect normal maintenance costs which would have been incurred had the upratings not been performed. For example, most uprated generators have been in need of replacement windings as part of normal generator maintenance. If the cost of performing needed rewinds were subtracted from the uprating costs (shown on the table), the actual cost per kilowatt increase for uprating would be considerably less than shown. As shown in Table C.3, the average cost per kilowatt increase for the 13 contracts is $49 per kilowatt. This compares to an average cost for providing new peaking capacity through oil-fired generator units of $400 per kilowatt. In addition, operation, maintenance, replacement, and fuel costs are minimal for new peaking capacity when compared to oil-fired generators.

Plant	Units	Old* Rating (kW)	New* Rating (kW)	Percent Change	Additional Kilowatts	Year to be Uprated
Hoover	1	109,250	130,000	19.0	20,750	1992
Hoover	2	82,500	130,000	57.6	95,000	1992
Hoover	1	40,000	61,500	53.7	21,500	1991
Hoover	1	50,000	68,500	37.0	18,500	1991
Keswick	1	25,000	39,000	56.0	14,000	1991
Keswick	1	25,000	39,000	56.0	14,000	1991
Keswick	1	25,000	39,000	56.0	14,000	1991
Morrow Point	2	60,000	78,000	30.0	36,000	1991-92
Flaming Gorge	3	36,000	50,495	40.3	43,485	1991-92
Hungry Horse	4	71,250	107,000	50.2	143,000	1991-93
Palisades	2	28,500	41,141	44.4	25,282	1992-95
Palisades	2	30,875	41,141	33.3	20,532	1992-95
TOTAL	21			43.5%	466,049	

*Per unit

Figure C-3 shows the absolute increases and costs per kilowatt for each Reclamation power uprate contract.

Plant	Units	Old* Rating (kW)	New* Rating (kW)	Additional Kilowatts	Contract Cost ($)	Cost Per kW ($)
Shasta	1,2	75,000	125,000	100,000	2,266,848	23
Anderson Ranch	1,2	13,500	20,000	13,000	1,079,279	83
Blue Mesa	1,2	30,000	43,200	26,400	1,789,500	68
Flatiron	1,2	31,500	43,020	23,040	1,042,499	45
Glendo	1,2	12,000	19,000	14,000	1,453,834	104
Hoover	A5, N7	82,500	127,000	89,000	4,641,567	52
Hoover	N3, N4	82,500	130,000	95,000	7,637,385	80
Hoover	N1,2,5,6	82,500	130,000	190,000	10,595,000	56
Hoover	A1,2,6,7	82,500	130,000	190,000	11,253,000	59
Fremont Canyon	1,2	24,000	33,400	18,800	994,500	53
Trinity	1,2	50,000	70,000	40,000	1,214,100	30
Glen Canyon	1,3,5,6	118,750	165,000	185,000	7,044,724	26
Glen Canyon	2,4,7,8	118,750	157,050	153,200	5,026,724	30
AVERAGE COST PER KW						49

*Per unit.

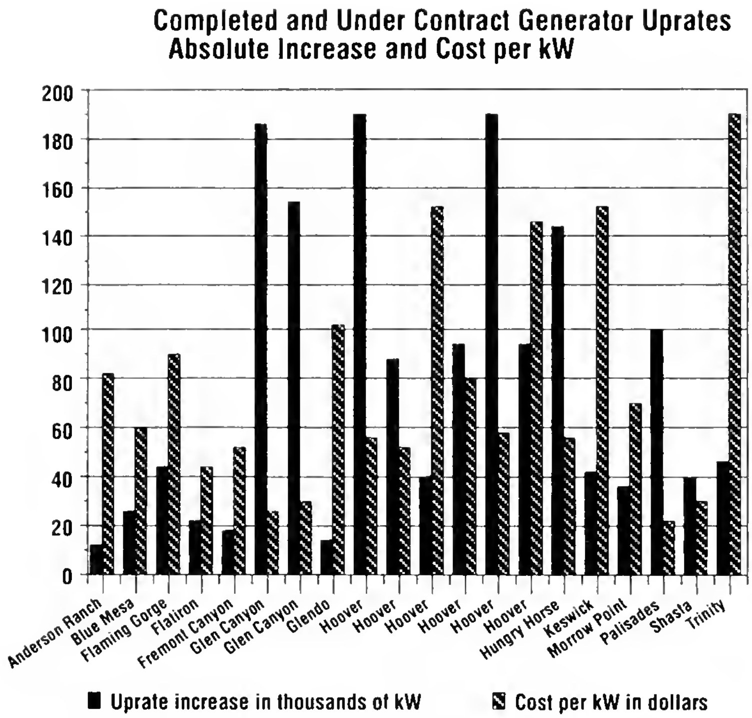


Figure C.4

The work on the eight units will essentially complete Reclamation's present uprating program. This program will have accounted for an increase in generating capacity of 2,000,000 kilowatts. About 30 percent of the generators were determined viable for uprating. The remaining units were either modern design (post mid-1960s) or were not feasible for uprating due to economic or water supply restrictions. Hence, the majority of generator rehabilitation work that can be foreseen will be rewinds or equipment modernization which may not result in increases in capacity. Several powerplants are so old and outdated that complete equipment replacement or a new facility would be required. In the future, new advances in technology — such as superconductivity — may make further generator uprates possible, much as advances in the insulation system used on generator windings in the 1960s made major capacity increases feasible and economically justifiable on many generators.

Presently, eight generating units (at three powerplant locations) have been identified as candidates for future uprating. Table C.4 shows the existing generator ratings. The exact increase in unit capacity to be gained through uprating cannot be determined until thorough uprating studies are done. Economic factors will help to determine the final uprated value.

Plant	Number of Units	Rating Each Unit (kW)	Current Projected Dates
Shasta	3	99,000	1992-94
Boise River Diversion	3	500	To Be Determined
Black Canyon	2	4,000	To Be Determined

Power Facilities Developed Through Lease or Contract

Power Facilities Developed on Reclamation Projects Through Lease of Power Privilege, Contracts, and Agreements

Project	Plant	State	Plant Size (kW)	Status
Grand Valley	Grand Valley	Colorado	3,000	operating
Florida	Lemon	Colorado	110	operating
Strawberry Valley	Upper Spanish Fork	Utah	3,500	operating
Strawberry Valley	Lower Spanish Fork	Utah	250	operating
Strawberry Valley	Payson	Utah	400	operating
Parker-Davis	Parker	California	120,000	operating
Salt River	Theodore Roosevelt	Arizona	36,000	operating
Salt River	Horse Mesa	Arizona	29,700	operating
Salt River	Mormon Flat	Arizona	9,200	operating
Salt River	Stewart Mountain	Arizona	10,400	operating
Salt River	Crosscut	Arizona	3,000	operating
Yuma	Siphon Drop	California	4,520	operating
Boulder Canyon				
All American Canal	Drop 1	California	5,850	operating
All American Canal	Drop 2	California	10,000	operating
All American Canal	Drop 3	California	9,800	operating
All American Canal	Drop 4	California	19,600	operating
All American Canal	Drop 5	California	4,000	operating
All American Canal	Pilot Knob	California	33,000	operating
Colorado River Front Work & Levee System	Senator Wash	California	7,200	operating
Provo River	Deer Creek	Utah	4,950	operating
Weber Basin	Gateway	Utah	4,500	operating
Weber Basin	Wanship	Utah	1,781	operating
Newlands	Lahontan	Nevada	1,920	operating
Central Valley	San Luis	California	424,000	operating
TOTAL CAPACITY			746,681	

Active FERC-Licensed Projects At Reclamation Facilities

FERC No.	Date Issued	Licensee	Capacity kW	Reclamation Facility	State	Status
2736	03/31/75	Idaho Power Co.	92,400	American Falls Dam	ID	O
2780	05/25/82	Solano ID	11,500	Monticello Dam	CA	O
2840	09/21/82	East, Quincy, & South Columbia Basin ID's	6,500	O'Sullivan Dam	WA	O
2848	02/17/81	Idaho Power Co.	12,800	Cascade Dam	ID	O
2849	11/16/81	East, Quincy, & South Columbia Basin ID's	26,000	Dry Falls Dam	WA	O
2888	03/10/83	City of Redding	3,530	Whiskeytown Dam	CA	O
2892	09/30/82	Friant Power Authority	30,600	Friant Dam	CA	O
2920	05/15/85	Truckee-Donner PUD	2,400	Boca Dam	CA	PD
2926	03/27/80	East, Quincy, & South Columbia Basin ID's	6,000	Potholes-East (Mile Marker #22.7)	WA	O
2937	08/20/82	East, Quincy, & South Columbia Basin ID's	3,800	Quincy Chute	WA	O
2958	06/08/82	Madera ID	3,280	Madera Canal	CA	O
3031	10/09/81	Shoshone ID	2,400	Garland Canal	WY	O
3174	10/05/81	Ptarmigan Resources & Energy, Inc.	5,800	Vallecito Dam	CO	O
3467	05/09/84	Owyhee ID et al.	3,500	Owyhee Dam	OR	O
2973	10/19/89	Fall River Rural Electric	4,800	Island Park Dam	ID	PD
4656	03/27/89	Boise-Kuna ID et al.	60,000	Arrowhead	ID	PD
5036	10/23/81	Boise-Kuna ID et al.	1,000	Main Canal No. 6	ID	PD
6913	10/02/89	Weber Basin Conservancy Dist.	9,500	West Gateway	UT	PD
3193	08/31/82	Santa Clara	3,900	Stony Gorge Dam	CA	O
3295	08/14/81	East, Quincy, & South Columbia Basin ID's	92,000	Summer Falls on Main Canal	WA	O
3403	12/18/80	Boise-Kuna ID et al.	1,900	Mora Drop	ID	PD
3603	09/08/83	City of Aspen	3,200	Ruedi Dam	CO	O
3755	12/07/84	City of Bountiful	4,500	Echo Dam	UT	O
3756	08/24/83	City of Bountiful	2,000	East Canyon Dam	UT	OH

FERC No.	Date Issued	Licensee	Capacity kW	Reclamation Facility	State	Status
3757	10/07/83 (Reissued 08/21/85)	City of Bountiful	1,000	Lost Creek Dam Joes Valley	UT UT	S OH
3819	11/18/89	Energenics Systems	2,800	Sugarloaf Dam	CO	O
3842	12/09/81	East, Quincy, & South Columbia Basin ID's	2,200	Eltopia Branch Canal	WA	O
3843	12/09/81	East, Quincy, & South Columbia Basin ID's	2,300	Potholes East (Mile Marker #66.0)	WA	O
3858	05/22/87	Big Wood Canal Company	4,800	Dietrich Drop	ID	O
3991	09/29/86	STS Energenics	1,750	Crosscut Diversion Dam	ID	S
4359	02/28/86	Gem ID et al.	5,000	Owyhee Tunnel No. 1	OR	UC
4597	03/16/84	Weber-Box	1,800	Pineview Dam	UT	UC
4720	10/15/85	City of Farmington	30,000	Navajo	NM	O
5226	10/31/85	County of Los Alamos	8,000	El Vado	NM	O
9214	10/02/88	Provo Hydro	200	Murdock Dam	UT	S
5357	12/14/84	Owyhee ID et al.	1,500	Mitchell Butte Canal Drop	OR	O
5765	09/08/83	Madera ID	440	Madera Canal	CA	O
5925	10/15/87	Town of Lyons	2,200	St. Vrain Canal	CO	PD
6687	07/12/83	El Dorado ID	950	El Dorado Main Canal No. 3	CA	UC
7252	04/29/83	Santa Clara	350	High Line Canal	CA	UC
7281	12/28/83	Madera ID	1,800	Madera Canal Lateral 450 (4 plants)	CA	O
7337	07/06/84	Yakima-Tieton ID	1,440	Yakima-Tieton Pipeline, Cowiche	WA	O
7338	07/06/84	Yakima-Tieton ID	1,350	Yakima-Tieton Pipeline, Orchard Ave. Drop	WA	O
7828	12/26/85	Truckee-Carson	5,000	Lahontan Dam	NV	PD
8492	06/23/86	Prodek, Inc.	150	McGee Creek Dam	OK	UC
TOTAL CAPACITY			**468,340 kW**			

PD - Project design
OH - On hold
S - Surrendered
UC - Under construction
O - Operating

Reclamation Power Facilities

Region	Project	Plant	State Location	River	Initial Date In Service	Number Of Units	Installed Capacity (kW)	Gross Generation (kWh)
PN	Boise	Anderson Ranch	Idaho	So. Fork, Boise	12-50	2	40,000	111,376,000
		Black Canyon	Idaho	Payette	12-25	2	8,000	53,089,000
		Boise River Div.	Idaho	Boise	5-12	3	1,500	300
	Columbia Basin	Grand Coulee	Washington	Columbia	3-41	33	6,494,000	23,750,411,625
	Hungry Horse	Hungry Horse	Montana	So. Fork, Flathead	10-52	4	285,000	879,646,000
	Minidoka	Minidoka	Idaho	Snake	5-09	7	13,580	67,854,000
	Palisades	Palisades	Idaho	So. Fork, Snake	10-52	4	127,300	528,739,000
	Rogue River Basin	Green Springs	Oregon	Trans. Mtn. Div.	5-60	1	16,000	63,416,000
	Yakima	Chandler	Washington	Yakima	2-56	2	12,000	53,304,000
		Roza	Washington	Yakima	8-58	1	12,937	67,944,000
TOTAL						59	7,010,317	25,575,779,925
MP	Central Valley	Judge F. Carr	California	Tunnel, Lewiston	5-63	2	154,400	342,076,000
		Folsom	California	American	6-55	3	198,720	400,409,000
		Keswick	California	Sacramento	10-49	3	89,000	360,847,000
		New Melones	California	Stanislaus	6-79	2	300,00	247,997,000
		Nimbus	California	American	5-55	2	13,500	53,073,200
		O'Neill	California	San Luis Creek	11-67	6	25,200	4,199,100
		San Luis	California	San Luis Creek	3-68	8	*202,000	122,850,000
		Shasta	California	Sacramento	6-44	7	539,000	1,278,015,500
		Spring Creek	California	Tunnel, Clear Creek	1-64	2	180,000	378,969,000
		Stampede	California	Little Truckee	9-87	2	3,650	8,885,990
		Trinity	California	Trinity	2-64	3	140,350	321,569,100
TOTAL						40	1,845,820	3,518,890,890
LC	Boulder Canyon	Hoover	Ariz./Nev.	Colorado	9-36	19	1,930,000	4,361,857,000
	Parker-Davis	Davis	Ariz./Nev.	Colorado	1-51	5	240,000	1,098,100,000
		Parker	Ariz./Calif.	Colorado	12-42	4	120,000	477,189,000
TOTAL						28	2,290,000	5,937,146,000

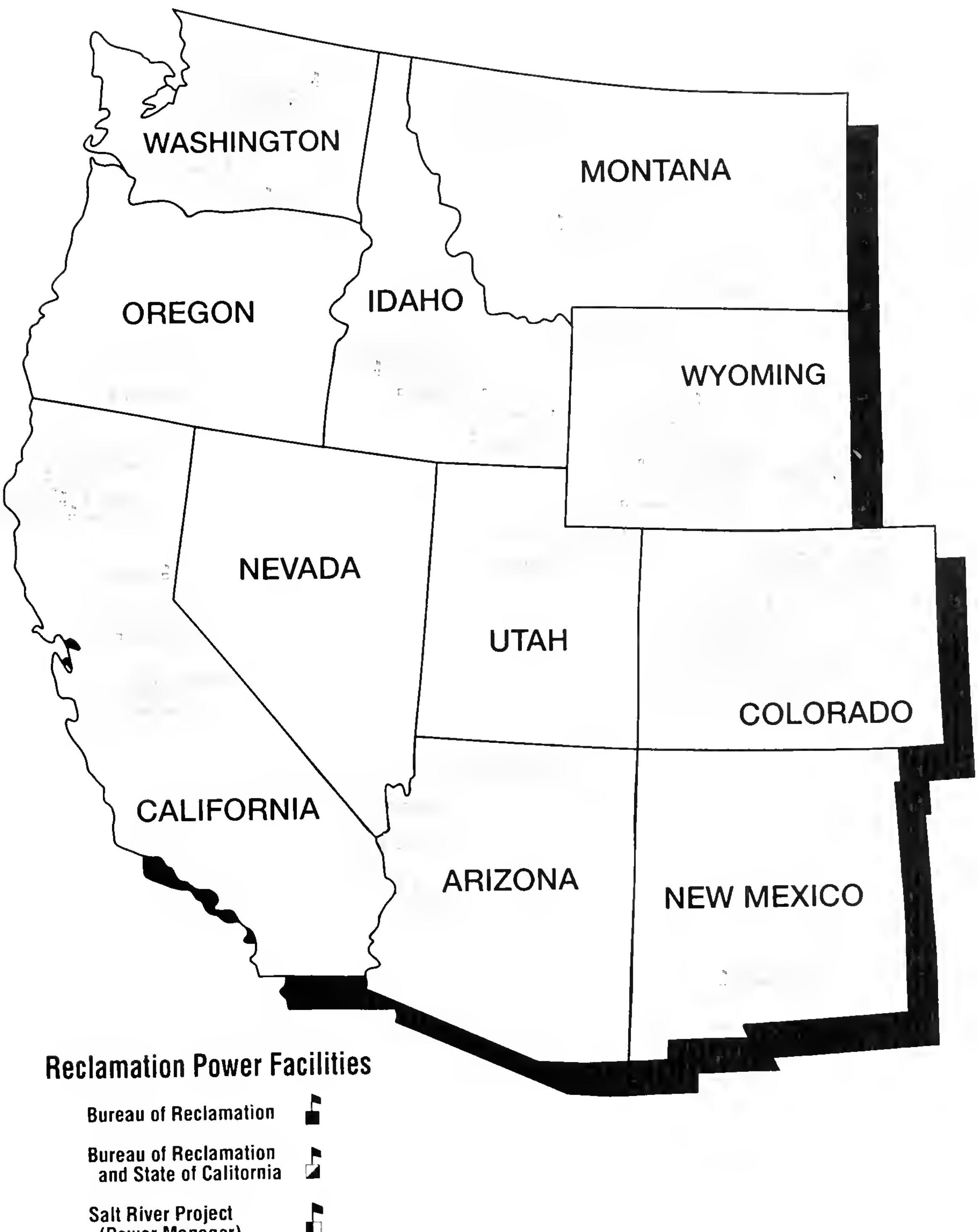
Region	Project	Plant	State Location	River	Initial Date In Service	Number Of Units	Installed Capacity (kW)	Gross Generation (kWh)
UC	Collbran	Lower Molina	Colorado	Pipeline	12-62	1	4,860	8,501,300
		Upper Molina	Colorado	Pipeline	12-62	1	8,640	26,268,400
	Colo. River Storage	Blue Mesa	Colorado	Gunnison	9-67	2	86,400	149,375,000
		Crystal	Colorado	Gunnison	6-78	1	28,000	91,181,000
		Flaming Gorge	Utah	Green	11-63	3	108,000	260,302,000
		Glen Canyon	Arizona	Colorado	9-64	8	1,288,184	3,793,819,000
		Morrow Point	Colorado	Gunnison	12-70	2	120,000	197,233,000
	Provo River	Deer Creek	Utah	Provo	2-58	2	4,950	19,057,000
	Rio Grande	Elephant Butte	New Mexico	Rio Grande	11-40	3	24,300	94,439,200
	Seedskadee	Fontenelle	Wyoming	Green	5-68	1	10,000	58,753,000
TOTAL						24	1,683,334	4,698,928,900
GP	Colo.-Big Thompson	Big Thompson	Colorado	Trans. Mtn. Div.	4-59	1	4,500	12,007,000
		Estes	Colorado	Trans. Mtn. Div	9-50	3	45,000	95,483,000
		Flatiron	Colorado	Trans. Mtn. Div.	1-54	3	94,500	234,047,000
		Green Mountain	Colorado	Blue	5-43	2	26,000	40,327,000
		Marys Lake	Colorado	Trans. Mtn. Div.	5-51	1	8,100	38,219,000
		Pole Hill	Colorado	Trans. Mtn. Div.	1-54	1	38,200	180,227,000
	Fryingpan-Arkansas	Mt. Elbert	Colorado	Trans. Mtn. Div.	6-81	2	200,000	108,113,141
	Kendrick	Alcova	Wyoming	North Platte	7-55	2	36,000	82,278,000
		Seminoe	Wyoming	North Platte	8-39	3	45,000	86,394,000
	North Platte	Guernsey	Wyoming	North Platte	7-27	2	4,800	10,852,000
	Pick-Sloan Mo. Basin	Boysen	Wyoming	Wind	8-52	2	15,000	65,824,000
		Canyon Ferry	Montana	Missouri	12-53	3	50,000	284,952,000
		Fremont Canyon	Wyoming	North Platte	12-60	2	66,800	174,559,000
		Glendo	Wyoming	North Platte	12-58	2	38,000	47,998,000
		Kortes	Wyoming	North Platte	6-50	3	36,000	103,884,000
		Pilot Butte	Wyoming	Wind	1-25	2	1,600	2,825,000
		Yellowtail	Montana	Big Horn	8-66	4	250,000	688,916,000
	Shoshone	Heart Mountain	Wyoming	Shoshone	12-48	1	5,000	23,655,000
TOTAL						39	964,500	2,280,560,141

Grand Totals:

Number of Plants	-	52
Number of Units	-	190
Installed Capacity	-	13,793,971 kW
Gross Generation	-	42,011,305,856 kWh

*Federal share of 424,000 kW installed capacity - plant operated by the State of California
NOTE: Shoshone Powerplant not shown as it was not in operation in 1990

Map of Reclamation Power Facilities



Glossary of Terms and List of Abbreviations

TERM	DEFINITION
Acid rain	Rain having a pH of 5.6 or less, with a high concentration of acids produced by the solution of airborne sulfur dioxide, nitrogen dioxide, etc., resulting from the combustion of fossil fuels.
Advanced Decision Support System (ADSS)	Computer software designed to provide easy access to and allow efficient use of methods of analysis and information management.
Afterbay	A channel for conducting water away from a powerplant after it has passed through it.
Aquatic microphyte	A plant living in water, large enough to be seen with the naked eye.
Artificial intelligence (AI)	The subfield of computer science concerned with developing intelligent computer programs. This includes programs that can solve problems, learn from experience, understand language, interpret visual scenes and, in general, behave in a way that would be considered intelligent if observed in a human.
Auxiliary equipment	Accessory equipment necessary for the operation of a generating station.
Barrel	A liquid measure defined as 42 U.S. gallons.
Base load	The minimum electrical system load over a given period of time.
Benefit-cost ratio	The ratio of the present value of the benefit stream to the present value of the project cost stream used in economic analysis.
Best management practices	The state-of-the-art practices that are efficient and effective, practical, economical, and environmentally sound.
Blackout	The disconnection of the source of electricity from all the electrical loads in a certain geographical area brought about by an emergency forced outage or other fault in the generation, transmission, or distribution system serving the area.

Brownout	The partial reduction of electrical voltages. A brownout results in lights dimming and motor-driven devices slowing down.
Btu (British thermal unit)	A standard unit for measuring the quantity of heat required to raise the temperature of 1 pound of water by 1 degree Fahrenheit.
Bus (buswork)	A conductor or group of conductors that serves as a common connection for two or more circuits. In powerplants, buswork comprises the three rigid single-phase connectors that interconnect the generator and the step-up transformer(s).
Capacity	The load for which a generator, turbine, transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability.
Circuit breaker	Any switching device that is capable of closing or interrupting an electrical circuit.
Conservation	Increasing the efficiency of energy and water use, production, or distribution.
Coordinated operation	Generally, the operation of two or more interconnected electrical systems to achieve greater reliability and economy. As applied to hydropower resources, the operation of a group of hydropower plants to obtain optimal power benefits with due consideration to all other uses.
Coordination	The practice by which two or more interconnected electric power systems augment the reliability of bulk electric power supply by establishing planning and operating standards; by exchanging pertinent information regarding additions, retirements, and modifications to the bulk electric power supply system; and by joint review of these changes to assure that they meet the predetermined standards.
Cycling	Powerplant operation to meet the intermediate portion of the load (9 to 14 hours per day).
Dam	A structure for impounding water.
Demand	The rate at which electric energy is delivered to or by a system, part of a system, or a piece of equipment. It is expressed in kilowatts, kilovoltamperes, or other suitable units at a given instant or averaged over any designated period of time. The primary source of "demand" is the power-consuming equipment of the customers.
Dissolved oxygen (DO)	Perhaps the most commonly employed measurement of water quality. Low DO levels adversely affect fish and other aquatic life. The total absence of DO will lead to the development of an anaerobic condition with the eventual development of odor and esthetic problems. The ideal dissolved oxygen for fish life is between 7 and 9 mg/L. Critical levels of DO — for nearly all fish — are between 3 and 6 mg/L. Most fish populations cannot survive when DO falls below 3 mg/L.

E

Ecosystem — A complex system composed of a community of flora and fauna taking into account the chemical and physical environment with which the system is interrelated.

Efficiency — The ratio of useful energy output to total energy input, usually expressed as a percent.

Electric Power Industry — The public, private, and cooperative electric utility systems of the United States taken as a whole. This includes all electric systems serving the public; regulated investor-owned electric utility companies; Federal power projects and state, municipal, and other government-owned systems, including electric public utility districts; electric cooperatives, including generation and transmission entities; jointly owned electric utility facilities; and electric utility facilities owned by a lessor and leased to an electric utility firm.

Electric power system — Physically connected electric generating, transmission, and distribution facilities operated as a unit under one control.

Endangered species — Generally taken to mean any species or subspecies whose survival is threatened with extinction. [See P.L. 93-205 for legal definition, Endangered Species Act, sec. 3, (6).]

Electric and Magnetic fields (EMF) — An electric or magnetic field, or a combination of the two, as in an electromagnetic wave.

Energy — Power of doing work, considered as one of two fundamentals in the makeup of the physical universe (the other being mass). Usually measured in kilowatt-hours.

Energy conservation — The more efficient use of energy resources. Energy conservation seeks to reduce energy invested per unit of product output, service performed, or benefit received through waste reduction.

Expert system — A computer program that uses expert knowledge to attain high levels of performance in a problem area. These programs typically represent knowledge symbolically, examine and explain their reasoning processes, and address problem areas that require years of special training and education for humans to master.

F

Federal Energy Regulatory Commission (FERC) — Established in 1977 (replacing the Federal Power Commission) with the primary responsibility of ensuring the Nation's consumers adequate energy supplies at just and reasonable rates and providing regulatory incentives for increased productivity, efficiency, and competition. Its primary functions are to establish and enforce rates and regulations regarding interstate aspects of the electric, natural gas, and oil industries. It also issues licenses for non-Federal hydroelectric plants and certifies small power production and cogeneration facilities.

Flashboards — Temporary structures installed at the tops of dams, gates, or spillways for the purpose of temporarily raising the water surface elevation, and hence the gross head of a hydroelectric generating plant, thus increasing power output. Normally, flashboards are removed either at the end of the water storage season or during periods of high streamflow, or for the purpose of temporarily increasing flood control.

Forced outage	The occurrence of a component failure or other condition which requires that a unit be removed from service immediately, in contrast to a planned or scheduled outage.
Forebay	The impoundment immediately above a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (storage, run-of- river, and pumped-storage).
Fossil fuels	Materials found in the earth's crust and formed from organic matter as a result of geological processes occurring over many millions of years. The conventional forms of energy in wide use today — coal, petroleum, and natural gas — are all fossil fuels.
Fossil fuel plant	A plant using coal, oil, gas, or other fossil fuel as its source of energy.
Gaseous supersaturation	The condition of higher levels of dissolved gases in water due to entrainment, pressure increases, or heating.
Generation	The process of producing electric energy by transforming other forms of energy; also, the amount of electric energy produced, expressed in kilowatthours.
Generator	A machine that converts mechanical energy into electrical energy.
Global warming	The possible result of an increase in atmospheric concentrations of carbon dioxide, methane, chlorofluorocarbons, and other "greenhouse" gases that trap additional heat in the atmosphere. The increase in greenhouse gases is caused by the combustion of fossil fuels (coal, petroleum, and natural gas), land use modification, and the release of agricultural and industrial gases into the atmosphere.
Gross generation	The total amount of electrical energy produced by a generating station or stations, measured at the generator terminals.
Habitat	An area where a plant or animal lives. (Sum total of environmental conditions in the area.)
Head	The differential of pressure causing flow in a fluid system, usually expressed in terms of the height of a liquid column that the pressure will support.
Headwater	Water upstream of a dam or powerhouse.
Hydraulic	Having to do with water in motion.
Hydroelectric plant	A plant in which the turbine generators are driven by falling water.

Hydroelectric power	The harnessing of flowing water to produce electrical energy.
Hydroelectric project	The complete development of a hydroelectric power site. This includes dams, reservoirs, transmission lines, and accessories needed for the maintenance and operation of the powerhouse and any other hydroelectric plant support facilities.
Hydrogen	The first chemical element, symbol H, in the periodic table, atomic number 1, atomic weight 1.00797; under ordinary conditions it is a colorless, odorless, tasteless gas.
Hypolimnetic	Pertaining to the lower, colder portion of a lake, separated from the upper, warmer portion (epilimnion) by a thermocline.
Independent power producers	Non-utility owned electric resources.
Insolation	The total amount of solar radiation (direct, diffuse, and reflected radiation) reaching an area, usually expressed in watts per square meter.
Interruptible demands	Those demands that, by contract, can be interrupted in the event of a capacity deficiency on the supplying system.
Kilowatt (kW)	Unit of electric power equal to 1,000 watts, or about 1.34 horsepower.
Kilowatthour (kWh)	The basic unit of electric energy, equaling an average of 1 kilowatt of power applied over one hour.
Lease of power privilege	A contractual right given to a non-Federal entity to utilize, consistent with project purposes, water power head and storage from Reclamation projects for electric power generation.
License	The basic form of FERC authorization to construct a new project or continue operating an existing project. Every operating hydroelectric project subject to Commission jurisdiction must have either a license or an exemption.
Load	The amount of electrical capacity or energy delivered at a given point.

Maintenance outage	The removal of a unit from service to perform work on specific components which could have been postponed past the next weekend.
Megawatt (MW)	Unit of electrical power equal to 1,000,000 watts, or about 1,340 horsepower.
Megawatt-hour (MWh)	One million watt-hours.
Mill	A monetary cost and billing unit used by utilities; it is equal to 1/1000 of the U.S. dollar (equivalent to 1/10 of one cent).
Multipurpose dam	A barrier constructed for two or more purposes such as storage, flood control, navigation, power generation or recreation.
Multiple-purpose reservoir	A reservoir planned to operate for more than one purpose.
Non-utility generators (NUGs)	Facilities for generating electricity that are not owned exclusively by an electric utility and which operate connected to an electric utility system.
North American Electric Reliability Council (NERC)	The principal organization for coordinating, promoting, and communicating about reliability for North America's electric utilities. NERC was formed in 1968 in the aftermath of the November 9, 1965 Northeast Blackout.
Nutrients	Animal, vegetable, or mineral substance which sustains individual organisms and ecosystems.
Off-peak energy	Electric energy supplied during periods of relatively low system demands.
On-peak energy	Electric energy supplied during periods of relatively high system demands.
Outage	The period during which a generating unit, transmission line, or other facility is out of service.

Peak load	The maximum load in a stated period of time. The peaking portion of the load is that portion of the load that occurs for less than 8 hours per day.
Penstock	A conduit used to convey water under pressure to the turbines of a hydroelectric plant.
Plant	A station at which are located prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or nuclear energy into electric energy.
Plant factor	The ratio of the average load on the plant for the period of time considered to be the aggregate rating of all the generating equipment installed in the plant.
Power	The rate at which energy is transferred, usually measured in watts. Also used for a measurement of capacity.
Powerplant	A structure that houses the turbines, generators, and associated control equipment.
Power pool	Two or more interconnected electric systems which operate as a single system to supply power to meet combined load requirements.
Preference	Priority access to Federal power by public bodies and cooperatives.
Preference customers	Publicly owned systems and non-profit cooperatives which by law have preference over investor-owned systems for the purchase of power from Federal projects.
Preliminary permit	A FERC authorization granting priority right to file a license application and authorizing the permittee to conduct studies and analyses necessary to prepare a complete license application. A preliminary permit does not permit any construction.
Production (electric)	Act or process of producing electrical energy from other forms of energy; also, the amount of electrical energy produced expressed in kilowatthours (kWh).
Production expenses	Costs incurred in the production of electric power and conforming to the accounting requirements of the Operation and Maintenance Expense Accounts of the FERC Uniform System of Accounts.
Productivity	The quality of creating something of value.
Public Utility Regulatory Policies Act of 1978 (PURPA)	Federal legislation that, in part, requires utilities to purchase electricity from qualified independent power producers at a price that reflects what the utilities would have to pay for the construction of new generating resources. Portions of the act were designed to encourage the development of small-scale cogeneration and renewable resources.
Pumped-storage project	A hydroelectric plant that generates energy for periods of peak demand or emergency demand by using pumped storage; that is, water pumped previously (during off-peak periods) from a lower-elevation reservoir to a higher-elevation reservoir.
Pumping energy	The energy required to pump water from the lower reservoir to the upper reservoir of a pumped-storage project.

Ramp rate	The maximum allowable rate of change in output from a powerplant. The ramp rate is established to prevent undesirable effects due to rapid changes in loading or, in the case of hydroelectric plants, discharge.
Reliability	The probability that a device will function without failure over a specified time period or amount of usage.
Relicensing	The administrative proceeding in which FERC, in consultation with other Federal and State agencies, decides whether and on what terms to issue a new license for an existing hydroelectric project at the expiration of the original license.
Reservoir	An artificial lake into which water flows and is stored for future use.
Reversible turbine	A hydraulic turbine, normally installed in a pumped-storage plant, which can be used alternatively to generate electricity or to pump water to a higher elevation.
Riparian	Living on or adjacent to a water supply such as a riverbank, lake, or pond.
Runner	The rotating part of a turbine.

Selective withdrawal structures	Devices which permit releases from a reservoir over a wide range of depths, temperatures, or water quality.
Spinning reserves	The unused capacity in generator units that are in operation which can be called upon for immediate use in case of system problems or sudden load changes.
Standby reserves	The unused capacity in an electric system in machines that are not in operation but that are available for immediate use if required.
Station use	Energy used in a generating plant as necessary in the production of electricity. It includes energy consumed for plant light, power, and auxiliaries regardless of whether such energy is produced at the plant or comes from another source.
Steam plant	An electric powerplant that uses steam as the motive force of its prime movers. Steam plants can be either nuclear or fossil fuel-fired or they can use geothermal energy.
Stratification	Thermal layering of water in lakes and streams. Lakes usually have three zones of varying temperature: epilimnion — top layer; metalimnion (thermocline) — middle layer of rapid temperature change; and hypolimnion — bottom layer.
Substation	An assemblage of equipment for the purposes of switching and/or changing or regulating the voltage of electricity.

Switchgear	A general term covering switching and interrupting devices and their combination with associated control, instrumentation, metering, protective and regulating devices; also assemblies of these devices with associated interconnections, accessories, and supporting structures used primarily in connection with the generation, transmission, distribution, and conversion of electric power.
System interconnection	A connection between two electric systems permitting the transfer of electric energy in either direction.
Threatened species	Any species which has the potential of becoming endangered in the near future. [See Endangered Species Act, P.L. 93-205 for legal definition, sec. 3 (20).]
Transformer	An electromagnetic device used to change the voltage of alternating current electricity.
Transmission	The transporting or conveying of electric energy in bulk to a convenient point at which it is subdivided for delivery to the distribution system. Also used as a generic term to indicate the conveying of electric energy over any or all of the paths from source to point of use.
Turbidity	A measure of the extent to which light passing through water is reduced due to suspended materials. Excessive turbidity may interfere with light penetration and minimize photosynthesis, thereby causing a decrease in primary productivity. It may alter water temperature and interfere directly with essential physiological functions of fish and other aquatic organisms, making it difficult for fish to locate a food source.
Turbine	A machine for generating rotary mechanical power from the energy in a stream of fluid (such as water, steam, or hot gas). Turbines convert the energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two.
Watershed	An entire drainage basin including all living and nonliving components of the system.
Watt	Basic unit of electrical power produced at a particular instant in time.
Western Systems Coordinating Council (WSCC)	A reliability council organized in August of 1967, which provides the coordination that is essential for operating and planning a reliable and adequate electric power system for the western part of the continental United States, Canada, and Mexico.
Wetlands	Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have the following three attributes: (1) at least periodically, the land supports predominately hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is on soil and is saturated with water or covered by shallow water at some time during the growing season of each year.
Wind turbine generator	A generator powered by a turbine driven by the wind.

ADSS	Advanced Decision Support Systems
AI	Artificial Intelligence
APPA	American Public Power Association
BPA	Bonneville Power Administration
Btu	British thermal unit
CE	Categorical Exclusion
COE	Corps of Engineers
DIST	District
DO	Dissolved Oxygen
DOE	Department of Energy
EA	Environmental Assessment
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EPRI	Electric Power Research Institute
FERC	Federal Energy Regulatory Commission
FONSI	Finding of No Significant Impact
FY	Fiscal Year
GP	Great Plains Region, Bureau of Reclamation
ID	Irrigation District
IEEE	Institute of Electrical And Electronics Engineers
IPP	Independent Power Producer
kW	kilowatt
kWh	kilowatthour
LC	Lower Colorado Region, Bureau of Reclamation
mg/L	Milligram per liter
MP	Mid-Pacific Region, Bureau of Reclamation
MW	Megawatt
MWh	Megawatt-hour
NEPA	National Environmental Policy Act
NERC	North American Electric Reliability Council
NES	National Energy Strategy
NRECA	National Rural Electric Cooperative Association
NWRA	National Water Resources Association
NUGs	Non-utility Generators
O&M	Operation and Maintenance
P.L.	Public Law
PMA	Power Marketing Administration
PN	Pacific Northwest Region, Bureau of Reclamation
PUD	Public Utility District
PURPA	Public Utility Regulatory Policies Act
SSH	Small-Scale Hydroelectric
TVA	Tennessee Valley Authority
uc	under construction
UC	Upper Colorado Region, Bureau of Reclamation
U.S.C.	United States Code
USDI	United States Department of the Interior
USGS	United States Geological Survey
WAPA	Western Area Power Administration
WEES	Western Energy Expansion Study
WSCC	Western Systems Coordinating Council

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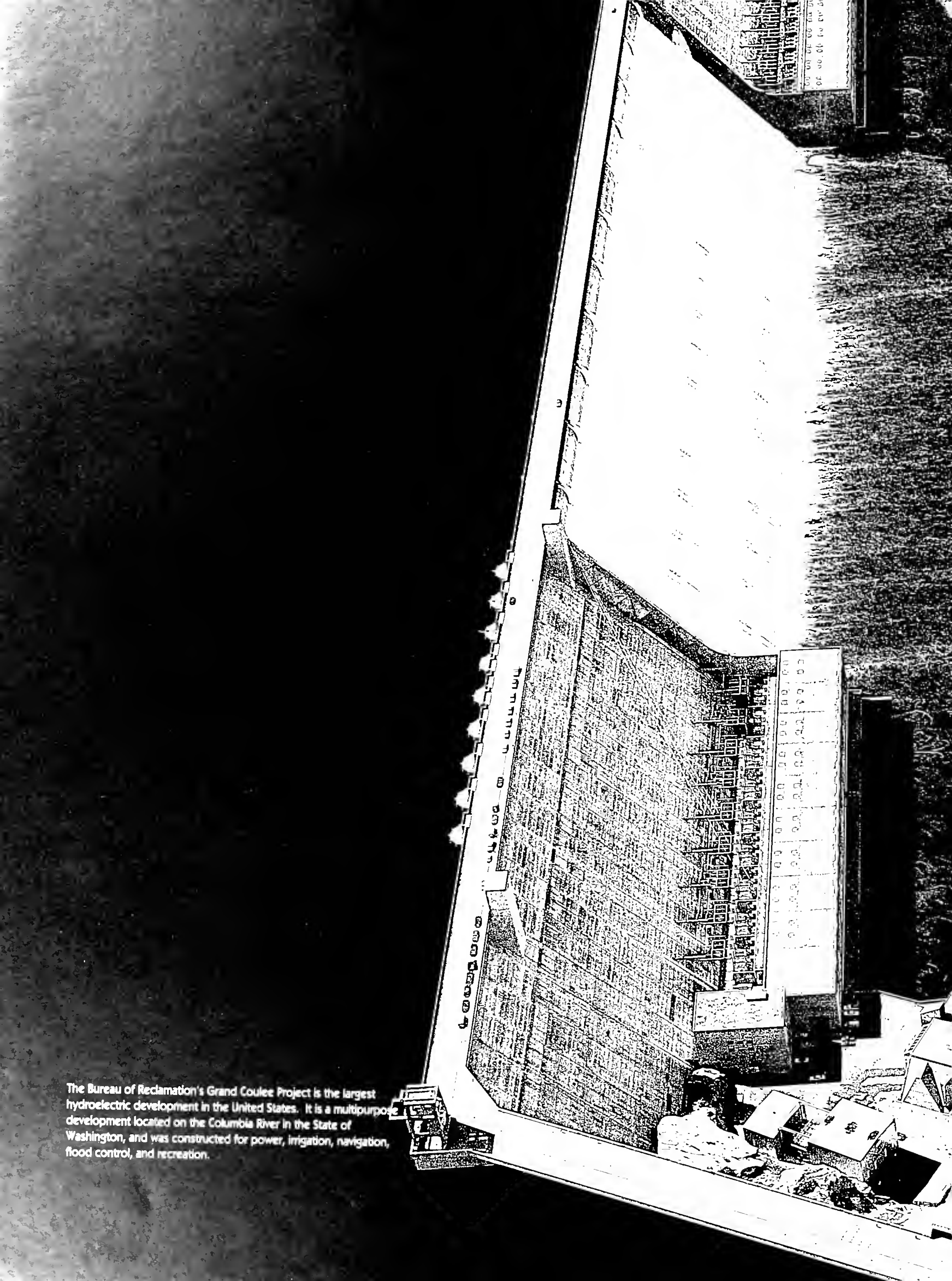
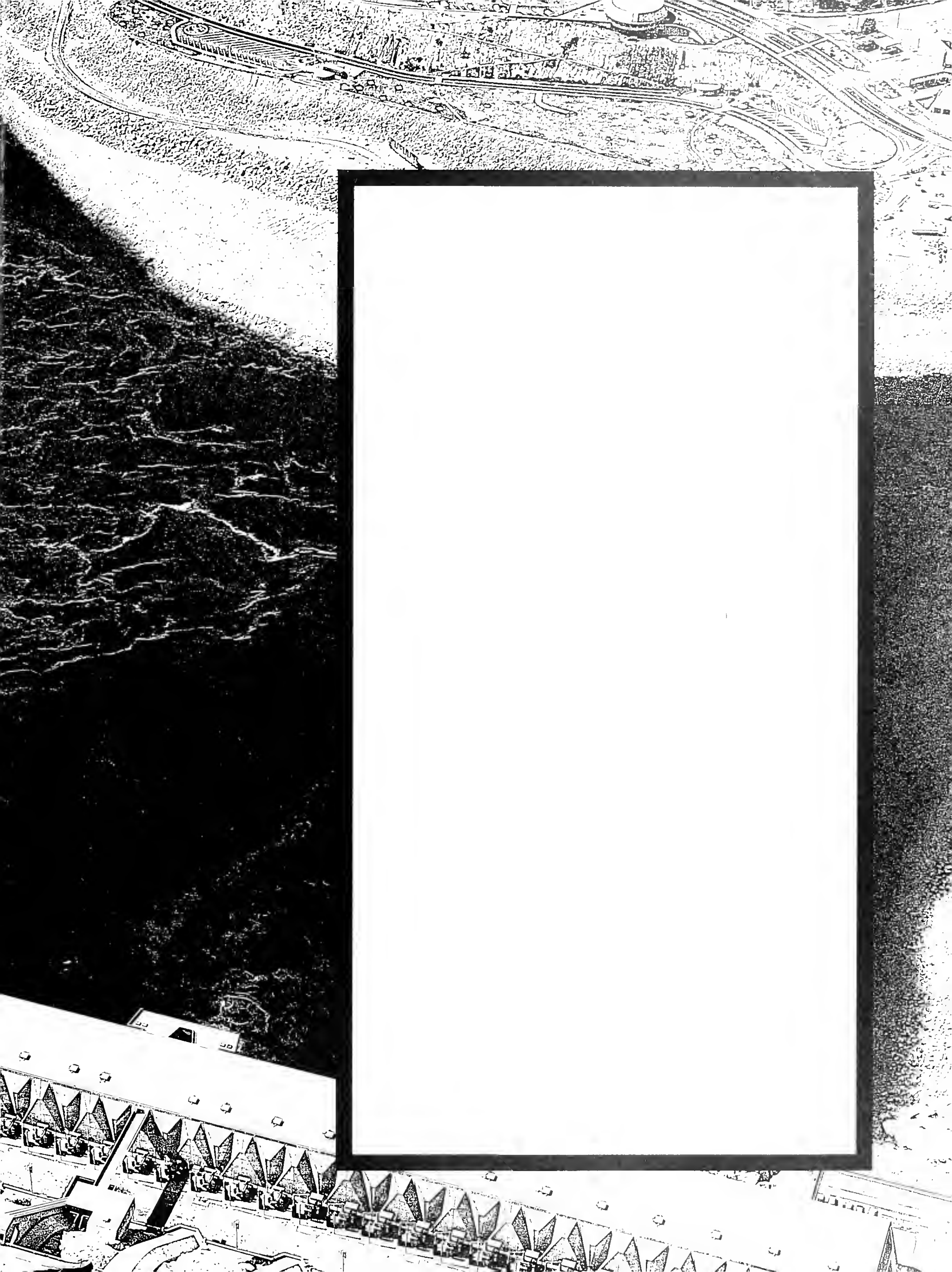


The Bureau of Reclamation's Grand Coulee Project is the largest hydroelectric development in the United States. It is a multipurpose development located on the Columbia River in the State of Washington, and was constructed for power, irrigation, navigation, flood control, and recreation.



TECHNICAL DOCUMENT

RECLAMATION 2002:

PLANNING FOR A GROWING NATION FOR 100 YEARS

The Bureau of Reclamation will celebrate its 100th anniversary in 2002. As Reclamation moves towards this milestone, it is strengthening its efforts to manage, develop, and protect water and related resources in the interest of the American public — providing for sustained economic growth , an improved environment, and quality of life.